budowa **Żuk**

eksploatacja naprawa

in English!

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translation put up by

http://zukowka.wordpress.com

The book describes all types of bodywork and power trains (including S-21, CB and 4C90 engines) of this popular commercial vehicle. The paper contains descriptions of all structural changes related to the modernization of the vehicle.

Beware: not every translation has been checked carefully. If something does not make sense, there is probably a mistake waiting to be fixed.

based on 1992's edition (ISBN: 83-206-0993-3)

version 20200303

Disclaimer:

As suggested in red on the front page, this translation is in no way official and has mostly be done via machine-learning, not by a professional.

The original technical documentation *Żuk budowa eksploatacja naprawa* is no longer being sold by its publisher and there is no announced plan to provide an English version; said publisher neither provides an alternative manual on topic.

As *Żuk budowa eksploatacja naprawa* is one of the rare manuals, with no real market value (around 20 PLN for a used one on allegro.pl in 2015), that cover a nowadays uncommon historical vehicle, we believe distributing its translation for free to be fair-use, as it is educational and contributing to road-safety. Were the original authors/publisher to release an English version of the manual, or a similar one, we would obviously consider discarding this project.

While computer automated translations are enough to get a general idea on the topic and while data in tables should be as accurate as in the original document, the whole translation process being partly automated implies errors, of interpretation but likely also of transcription.

If you are doing anything critical, you are more than advised to cross-check data with the original technical documentation *Żuk budowa eksploatacja naprawa*. If something seems dubious, assume that the translation may be faulty.

Already noticed odd translations are marked in yellow. Untranslated items are marked in orange. Incomplete or clearly erroneous items are marked in red. Added items, not in the original book, are marked in blue.

You are welcome to get in touch to provide any fixes or even just to ask us to crosscheck something.

To reach us, you can either post:

- a comment on the relevant blog post at http://zukowka.wordpress.com
- an issue on the gitlab issue tracker.

Contents

1 VEHICULE CHARACTERISTICS

Żuk low-capacity trucks, also known as vans, have a classic frame construction with an engine at the front and rear drive bridge.

1 VEHICULE CHARACTERISTICS

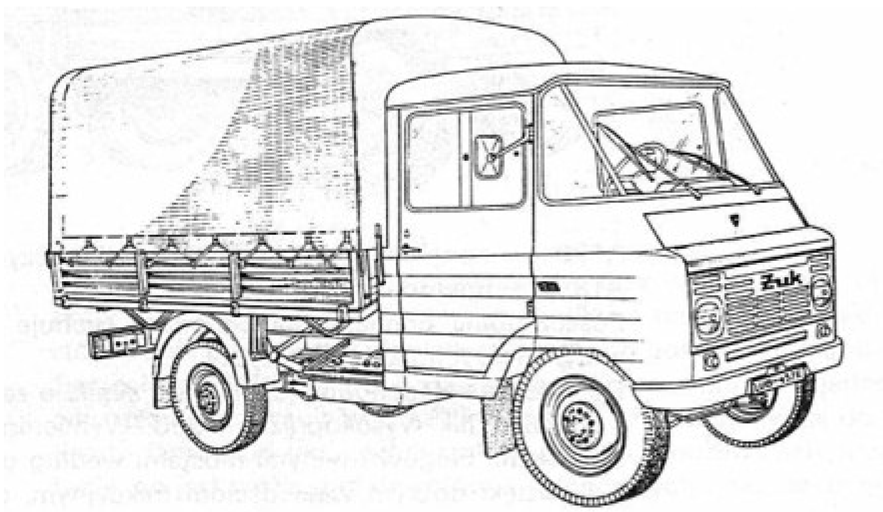
They are produced or intended to be produced in the following types and varieties:

- A06 - universal van,
- A061 - universal van with roof rack,
- A062 - van for transporting money and valuable parcels,
- A063 - tank wagon,
- A07 - cargo-passenger van,
- A071 - cargo-passenger van "LUX",
- A072 - cargo-passenger van with roof rack,
- A111 - box van,
- A15 - fire-fighting van with motor-pump,
- A1507 - fire-fighting commander,
- A151 - fire-fighting van with auto-pump,
- A161 - box with extended cab,
- A17 - isotherm container,
- A171 - universal container,
- A172 - special container,
- A173 - container with side door without window,
- A174 - container with side door and window in left wall,
- A175 - container for ambulant trade,
- A176 - containerized refrigerated aggregate,
- A18- minibus.

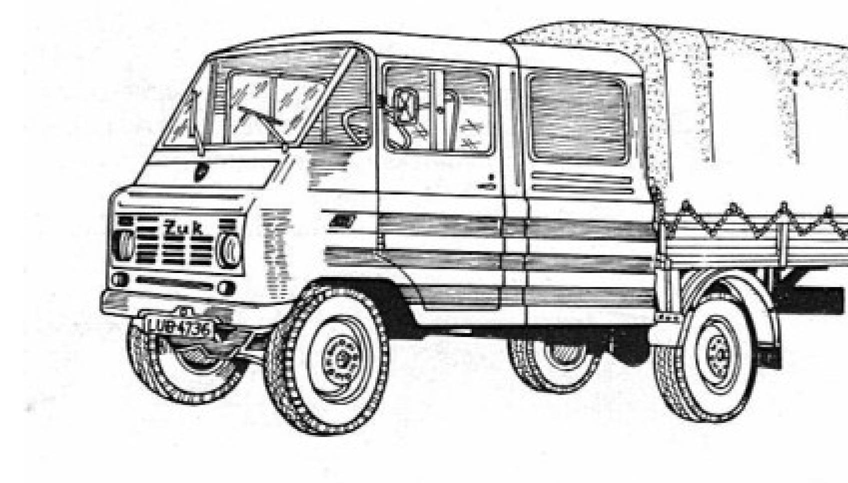
1.1. Figure: SAMOCHÓD ŻUK A06

1.2. Figure: SAMOCHÓD ŻUK A062

1.3. Figure: SAMOCHÓD ŻUK AO7

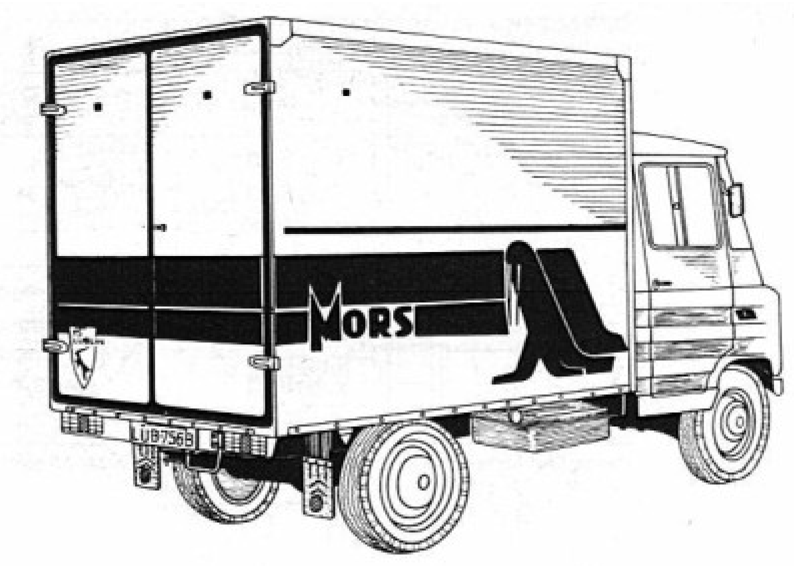


1.6. Figure: SAMOCHÓD ŻUK A15

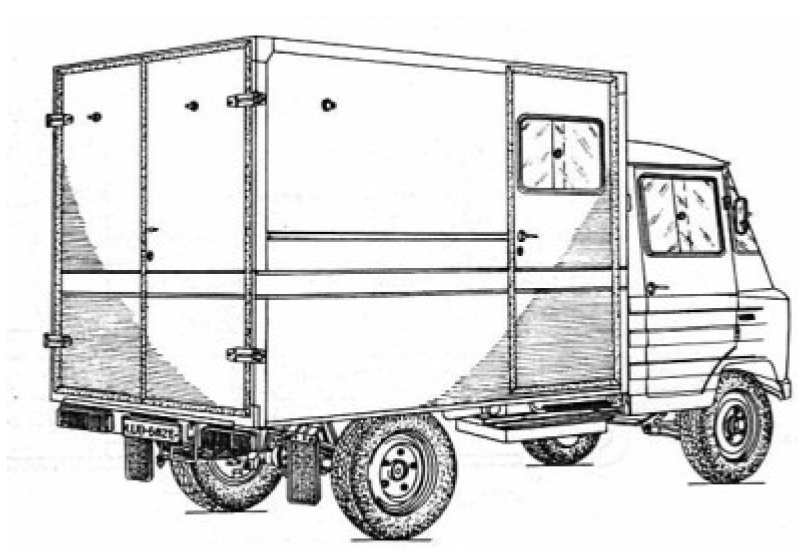


1.7. Figure: SAMOCHÓD ŻUK A161

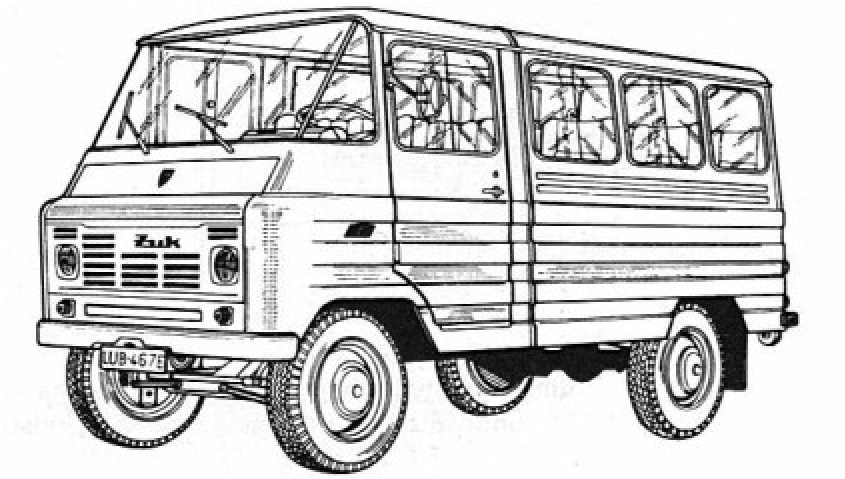
1.4. Figure: SAMOCHÓD ŻUK A151



1.8. Figure: SAMOCHÓD ŻUK A17



1.9. Figure: SAMOCHÓD ŻUK A174

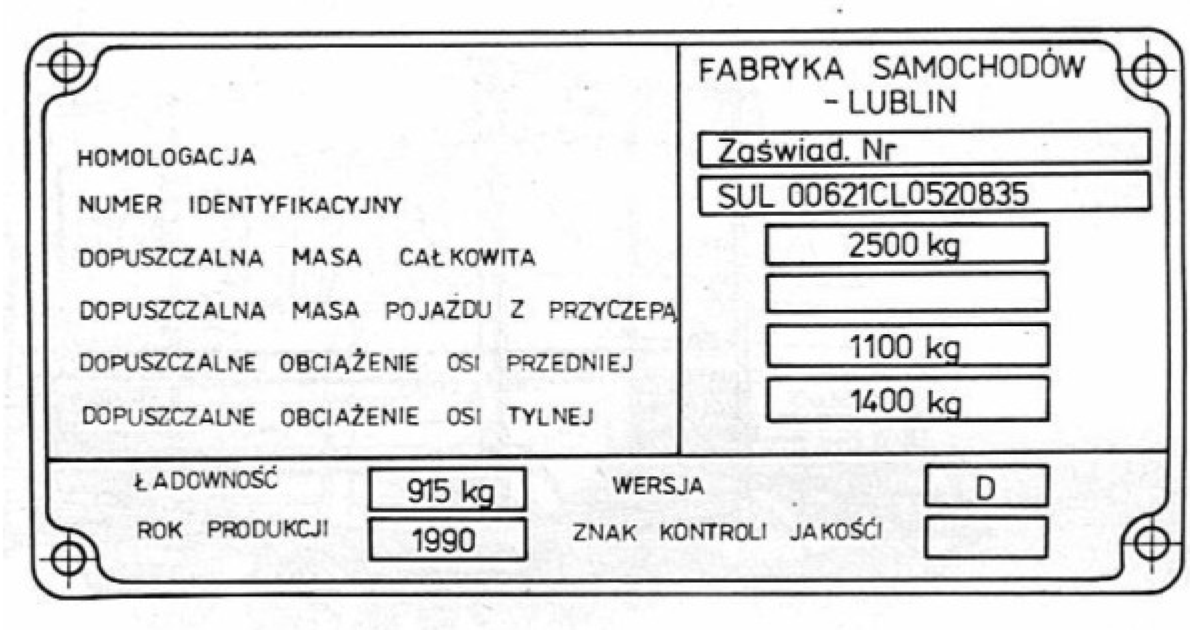


1.10. Figure: SAMOCHÓD ŻUK A18

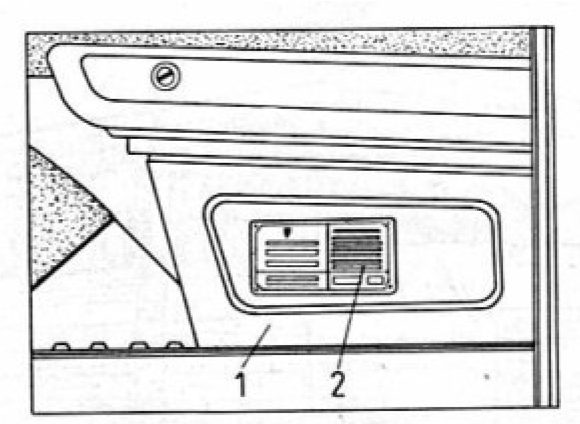
Different types of cars are characterized by high unification of chassis assemblies and driver's cabs. These engines are associated with gearboxes and rear bridges according to the system given in Table 1-1. Thanks to their good traction font, large font size, opacity of use, ease of driving and maintenance and repair, these vehicles are a popular means of transport, used in almost all branches of the national economy. ŻUK cars can be adapted to tow single-axle trailers (without brakes) with a maximum permissible weight of 750 kg. Each car is marked in such a way that it can be identified, which is necessary for recording and repair purposes.

Variety denomination	Engine	Gearbox	Rear drive axle
B	S-21	16	18
C	S-21	A 13.1	18
D	4C90	A 13.1	18
F	CB	Polonez 4	23
G	CB	Polonez 5	23
H	S-21	A 13.1	3005 (3015)
I	4C90	A 13.1	3005 (3015)

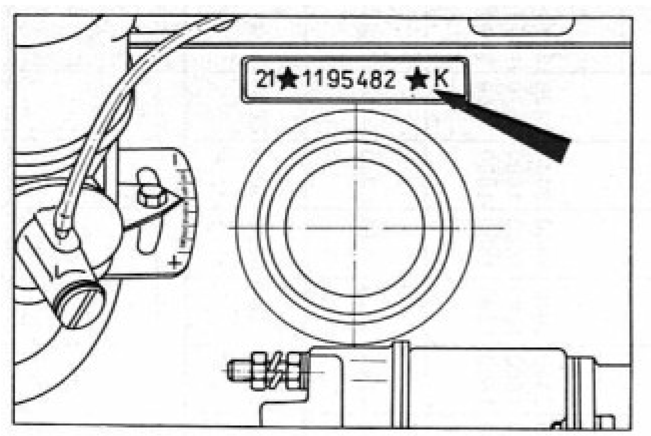
1.1. Table: ENGINE/GEARBOX/REAR AXLE DEPENDING ON VARIETIES OF ŻUK



1.11. Figure: IDENTIFICATION PLATE OF THE VEHICLE (TABLICZKA ZNAMIONOWA SAMOCHÓDU)



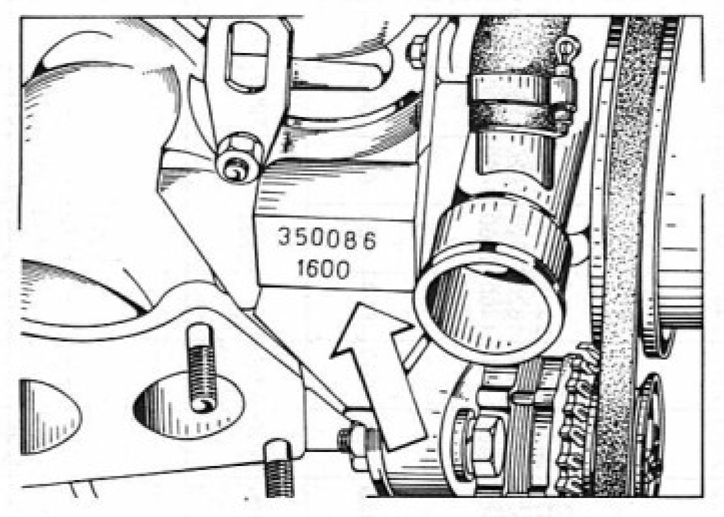
1.12. Figure: LOCATION OF THE IDENTIFICATION PLATE 1 - passenger seat base in the driver's compartment, 2 - plate



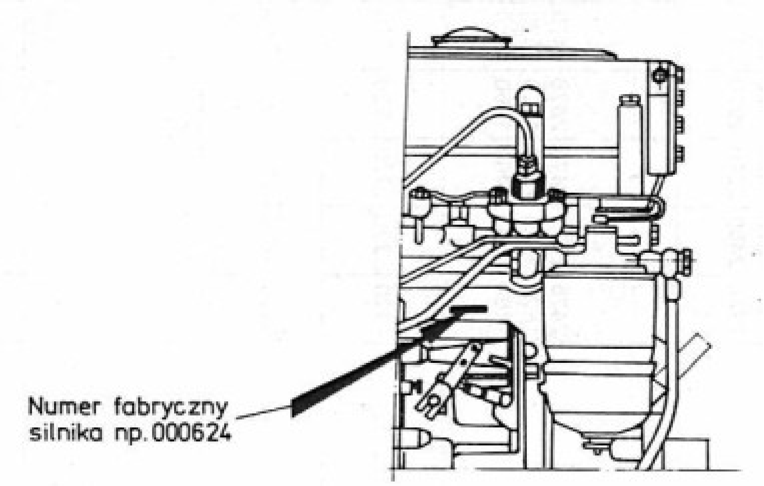
1.13. Figure: ENGINE S-21 - PRODUCTION NUMBER MARKING SITE

The main indications are:

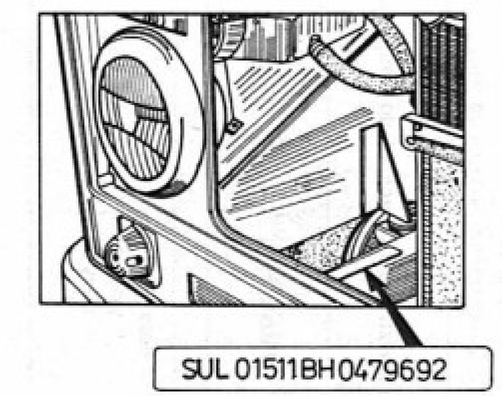
- the vehicle identification number stamped on the data plate (Fig. 1.11), located on the left-hand side of the base of the driver's seat (Fig. 1.12),
- engine number:
    - a) for engine S-21, pierced on the hull, next to the ignition distributor (Fig. 1.13),
    - b) for engine CB, pierced on the hull, next to the cooling system pump (Fig. 1.14),
    - c) for engine 4C90, pierced on the hull, above the injection pump (Fig. 1.15),
- chassis number (Fig. 1.16), pierced on a plate welded to the upper surface of the right side of the frame.



1.14. Figure: ENGINE CB - PRODUCTION NUMBER MARKING SITE



1.15. Figure: ENGINE 4C90 - PRODUCTION NUMBER MARKING SITE



1.16. Figure: THE PLACE WHERE THE CHASSIS NUMBER IS AFFIXED

1 VEHICULE CHARACTERISTICS

	A06	**A061**	**A062**	**A063**	**A07**	**A071**	**A072**	**A111**	**A15**	**A1507**	**A151**	**A161**	**A17**	**A171**	**A172**	**A173**	**A174**	**A175**	**A176**	**A18**
Outer contour																				
Length	4330	4330	4330	4330	4330	4330	4330	4615	4330	4330	4730	4550	4380	4380	4380	4380	4380	4380	4360	4330
Width	1820	1820	1820	1820	1820	1820	1820	1950	1820	1820	1820	1980	1850	1850	1850	1850	1850	1850	1850	1820
Height (no load)	2220	2460	2220	2220	2220	2220	2460	2527	2480	2460	2460	2527	2462	2462	2462	2462	2462	2462	2400	2220
Load compartment																				
Length	2475	2475	2475	2475	2475	2475	2475	2720	2475	2475	1820	1770	2440	2440	2440	2440	2440	2440	2425	2475
Width	1620	1620	1620	1620	1620	1620	1620	1850	1620	1620	1620	1855	1680	1680	1680	1680	1680	1680	16700	1600
Height	1460	1460	1460	1460	1460	1460	1460	400	1460	1460	1460	400	1680	1680	1680	1680	1680	1680	1560	1420
Charging surface height	720	720	720	720	720	720	720	1000	650	720	650	960	740	740	740	740	740	740	760	720
Wheelbase	2700																			
Wheelbase: **- front** **- rear**	1368 1375																			
Overview: **- front** **- rear**	610 1020	610 1020	610 1020	610 1020	610 1020	610 1020	610 1020	610 1300	610 1020	610 1020	1010 1020	610 1300	610 1070	610 1070	610 1070	610 1070	610 1070	610 1070	610 1140	610 1020
Ground clearance: **- transverse** **- longitudinal**	210 290																			

1.2. Table: ŻUK VEHICLE DIMENSIONS [mm]

	A06	A061	A062	A063	A07	A071	A072	A111	A15	A1507	A151	A161	A17	A171	A172	A173	A174	A175	A176	A18
Own weight	1525	1570	1660	1750	1550	1565	1650	1430	2200	1550	1835	1550	1650	1640	1640	1680	1680	1800	1775	1665
Maximum load	975	930	840 or 6 pass. + 390	750 or 5 pass. + 378	950 or 7 pass. + 425	935 or 5 pass. + 560	850 or 9 pass. + 175	1020	300 or 4 pass.	950 or 7 pass. + 425	665 or 3 pass. + 440	950 or 6 pass. + 470	850	860	860	820	820	700	725	160 + 9 pass.
Maximum laden mass	2500							2450	2500											
Unladen kerb mass distribution: **- front** **- rear**	875 650	875 695	860 800	875 875	840 710	850 715	910 740	820 615	910 1290	840 710	870 965	835 715	810 840	800 840	800 840	820 860	820 860	860 940	880 895	925 740
Total mass distribution: **- front** **- rear**	1100 1400	1100 1400	1050 1450	1100 1400	1100 1400	1100 1400	1100 1400	1000 1450	1100 1400	1100 1400	1100 1400	1050 1450	1100 1400	1100 1400	1100 1400	1100 1400	1100 1400	1100 1400	1100 1400	1100 1400
NB. Weights and loads are given in accordance with PN-84/S-02014, weight of one 75 kg passenger.																				

1.3 Table: MASSES IN VERSION B [kg]

The vehicle identification number on the data plate shall be 17 characters. The chassis number is a repetition of the vehicle identification number. In the illustrative indication given in Figures 1.11 and 1.16, the following letters and Figures indicate:

- S - Europe,
- U - Poland,
- L - Lublin,
- 006 - car type A06 (markings for other types and variants of ŻUK cars): 061 - A061, 062 - A062, 063 - A063, 007 - A07, 071 - A071, 072 - A072, 111 - A111, 015 - A15, 151 - A151, 157 - A157, 161 - A161, 017 - A171, 171 - A171, 172 - A172, 173 - A173, 174 - A174, 175 - A175, 018 - A18),
- 1 - the S-21 engine (designation for other engines: 2 - 4C90, 3 - CB),
- 1 - basic version of S-21 motor (model 16), B - drive train with S-21 motor, three-shift gearbox type 16 and rear axle type 18 with a ratio of 5.125 (symbols for other drive train according to table 1-1),
- L - code of 1990 production year (codes for other years - see PN-81/S-02051),
- 0525895 - the serial number of the vehicle.

1.1 DIMENSIONS

The basic dimensions of all types of ŻUK cars are given in Table 1-2.

1.2 MASS

The weights of all car variants in version B (according to PN-84/S-02014) are given in table 1-3, while the weights of cars in version C, D, H, I are larger, and in version F, G - smaller than in version B. The weights of cars in version C, D, H, I are smaller than in version B.

1.3 PERFORMANCE

The maximum speed of a fully laden car driven by the engine on a horizontal road with a hard, level, dry and clean surface in each gear is given in Table 1-4.

Gear	Version		
	B	C, D, H, I	F, G
I	34	28	33
II	60	44	64
III	105	71	96
IV	-	105	125
V	-	-	100
reverse	28	28	35

1.4. Table: MAXIMUM SPEED OF ŻUK VEHICLES [km/h]

Gear	Version		
	B	**C, D, H, I**	**F, G**
I	23	27	27
II	13	17	14
III	7	11	9
IV	-	7	7
V	-	-	5,5
reverse	27	27	25

1.5. Table: ABILITY OF ŻUK VEHICULES TO CLIMB THE HILLS [%]

Traffic conditions	Version		
	B, C, H (S-21)	**D, I (4C90)**	**F, G (CB)**
V = 70 km/h	11,5…12	8…9	9,5…10,5
V = 90 km/h	14…15	11…12	12…13
Urban driving	16…17,5	12…13	12,5…13,5

1.6. Table: ŻUK VEHICULES FUEL CONSUMPTION [dm^3]

The ability of a fully loaded vehicle, driven by its engine, to climb the hills on a road with hard, even, dry and clean surfaces in individual gears is shown in Table 1-5. The fuel consumption of the ŻUK vehicles according to PN-80/S 704000 is shown in Table 1-6.

1.4 TECHNICAL CHARACTERISTICS OF THE MAIN COMPONENTS

1.4.1 Engines

The S-21 2,120 dm^3 engine has a power output of 51,5 kW at 4000 rpm. The engine characteristics are given in Table 2-1. The 1,598 dm^3 CB engine has a power output of 64,0 kW at 5200 rpm. The engine characteristics are given in Table 2-28. 4C90 engine with a capacity of 2,417 dm^3 has a power output of 51.5 kW at 4200 rpm. The characteristics of the engine are given in Table 2-46.

1.4.2 Transmission(s)

- The dry single disc clutch has a flexible disc and a central pressure spring. The clutch disc is equipped with a torsional vibration damper. The clutch is switched off by means of a pedal, a pull-wire system, a lever and an extruder bearing.
- The gearboxes are mechanical gearboxes with fixed axles. Gearbox 16 has three forward and one reverse gears; gears II and III are synchronized. The A13.1 gearbox has four forward and one reverse gears: gears I to IV are synchronized. The Polonez gearbox has four or five forward gears and one reverse gear, 1-V gears are synchronized
- Single or split drive shaft, with intermediate support and length compensation at splined joint.
- The original rear axle (type 18 or 23) has a gear ratio of 5,125 (number of teeth 41 and 8) or 5,857 (number of teeth 41 and 7). The hypoidal rear axle (type 3005 or 3015) has a gear ratio of 4,778 (tooth numbers 43 and 9)

1.4.2 Transmission(s)

- The two-satellite differential has bevel gears with straight teeth.
- The drive axles are of the laden type.

1.4.3 Suspension and wheels

- The frame has two stringers with cross-bars made of a thin-walled closed profile with a rectangular cross-section and the front one made of an open, channel profile.
- The independent front suspension type is made up of suspension arms and screw springs. Inside the springs are hydraulic shock absorbers, telescopic double acting.
- The swivel stabilizer is a torsion bar connected to the frame and the lower front suspension arms.
- The rear suspension consists of two five leaf springs, semi-elliptical, with hydraulic dampers and telescopic double acting dampers.
- The wheel discs, with their 4.50Ex16 rims, are radially marked: 6,50R16C 10PRD-100 Nylon/Steel and inner tubes 6.00/6.50 16 Butyl I GP5 by 16 mm.

1.4.4 Steering/braking mechanisms

The steering mechanism consists of a globoidal transmission with a gear ratio of 18,2 (medium), a folding steering shaft with two cross joints (Nadella type) and a steering wheel on the left.

- The trapezoidal steering mechanism with center stick on two intermediate levers and with two outer (side) levers is connected to the steering mechanism by means of an intermediate stick.
- Vacuum assisted service brake - hydraulic, dual-circuit, drum brake acting on all wheels; circumference and including front axle wheels, circumference II - rear axle wheels.
- The mechanical (parking) emergency brake acting on the rear axle wheels is controlled by a lever (with ratchet mechanism) located on the floor support in the driver's cab.

1.4.5 Bodywork

The characteristics of the bodies are given in Chapter 6.

- One-piece cabin and side doors in the bodywork are hinged at the front and have an opening angle of 90°.
- The two-part rear door of a van-type bodywork shall be capable of being opened vertically. The upper sash is equipped with a scissor support, which keeps it open at an angle of 90°. The lower sash opens 180° or 90° on two chains. There is also an alternative solution for the rear door of a van-type body in the form of a single sash that can be opened vertically. It is equipped with two gas springs which support opening and are locked at an angle of 90° by a rod support. In container type vehicles, the rear door leaves are opened horizontally by 270° and the side doors by 90°. ŻUK A111 and A161 cars are equipped with a sheet with arches.
- The load compartment floor is made of wood on all models.

1.4.5 Bodywork

- The locks of the locking type are lockable with a key.
- Single-layer window panes are made of tempered glass (safety glass).
- The driver's anatomical forward and rearward-facing seat has adjustable backrest tilt. The position can be determined by means of a lever-type locking mechanism and the backrest tilt can be adjusted by means of a screw-type locking mechanism. The passenger seat in the driver's cab is swivelable (hinges at the front). It has no adjustment for displacement and no adjustment for backrest tilt.
- The benches in the passenger compartment of the cars towos, A157 and with an extended cabin are folded. In the car A15 there is a tiltable sofa, located on the rear wall of the cabin, on the cover of the box with extinguishing equipment, and in the car A151 - a one-person tiltable straponten, attached to the rear wall of the cabin. The passenger space of the minibus is equipped with armchairs for seven people, with front and middle armchairs for two people and a rear seat for three people.
- The heating system in the driver's cab is water-based, the two heaters are supplied with liquid from the engine cooling system. Two electric blowers, located in the heater housings, blow the driver, passenger and windscreen. The outlets are regulated by the air stream blades and blades. In the passenger compartment of the minibus and goods, an additional heater with a blower is or can be installed.
- Ventilation of the driver's cab is supply and exhaust air, with the possibility of using heating blowers, sliding side door windows and through ventilation holes in the rear door frame posts. The ventilation of the loading and passenger compartment in vans is extracted, through the openings of the sliding windows and through the openings of the ventilation in the side walls of the body. Container-type bodies without side glazed doors shall not be ventilated and shall be constructed in such a way as to be leak-proof.

  The driver's cabs are included as standard:

  - wiper 1 set
  - windscreen washer system with foot pump 1 set
  - exterior rear-view mirrors 2 pcs.
  - sun visors 2 pcs.
  - clothes hangers 2 pcs.
  - ashtray 1 pcs.
  - floor mats 1 set

1.4.6 Electrical equipment

The 6SC45 battery with a capacity of 45 Ah is installed in all cars of the D version (2 pcs. each).

The 6SE6OMN 60 Ah battery is installed in all other vehicle versions and variants (1 pcs. each).

1.4.6 Electrical equipment

The A124F 616 W alternator is mounted on S-21 and 4C90 motors, the A124 740 W alternator is mounted on a CB motor.

Controls:

- type RC2/12D for alternator A124F,
- type RC2/12E for alternator A124.

Ignition coils:

- Type 4220 for the S-21 engine,
- type 4226, compatible with the GL electronic module 118 12 V (as for CB engine), for S-21 engine with electronic ignition,
- type 4226, compatible with the GL electronic module 118 12 V for CB engine with electronic ignition.

Ignition distributor with centrifugal and vacuum control of the ignition advance angle:

- type 4444 for the S-21 engine,
- type 4484 for the S-21 engine with electronic ignition,
- type 4498 for the CB engine.

Spark plugs:

- F75 Iskra for S-21 engine,
- FE65P Iskra or N9Y Champion for CB engine.

Glow plugs:

- 137MJ BERU or PAL1506/A4.3 224004186 - for 4C90 engine.

Starters:

- type R5C with a power of 1,3 kW for the S-21 engine,
- type R11C with a power of 2,9 kW for the 4C90 engine,
- type 100N with a power of 1,5 kW for the CB engine.

External lamps:

- front: two main-beam headlamps (60 W) and an asymmetrical dipped-beam headlamp (55 W), a position lamp (4 W), a direction-indicator lamp (21 W), in addition to the fog lamp (55 W) for extinguishing vehicles,
- rear lamps: position lamps (5 W and 10 W for box vehicles), direction indicators (21 W), service brake braking lamps (21 W), registration plate lamps (3x5 W and 10 W for box vehicles), reversing lamps (21 W), fog lamps (21 W) and retro-reflectors;
- side: direction-indicator lamps (4 W) for all models and versions,
- top: flashing lamps (16 W) for fire-fighting vehicles only (on the cab roof)

1.4.6 Electrical equipment

10-socket fuse box (2 pcs./car).

1.5 ESSENTIAL CONTROL AND REGULATORY DATA OF THE VEHICLE

The basic control and regulatory data for ŻUK vehicles are given in Table 1-7; the capacity of tanks, systems and assemblies are given in Table 1-8.

version	**B, C, H**	**F, G**	**D, I**
engine	**S-21**	**CB**	**4C90 (A4/3)**
1	2	3	4
Compression pressure	0,98…1,08 MPa	1,03…1,08 MPa	3,0 MPa
Cold valve lashings: - suction valves - exhaust valves	0,20…0,22 mm 0,30…0,32 mm	0,20 mm 0,25 mm	0,20 mm 0,20 mm
Basic control elements for carburettors	see table 2-18		-
Setting values of the injection pump	-		see table 2-52
Oil pressure: - minimum - maximum	0,08 MPa 0,54 MPa	0,1 MPa 0,45 MPa	0,1 MPa 0,45 MPa
Thermostat switch-on: - commencement of the opening - maximum opening	68...4 °C 78…83 °C	80…84 °C 96 °C	
Fan activation temperature measured in the top tank of the radiator	-	84…90 °C	
Bending of the timing belt of the injection pump drive and the system camshaft (at thrust force)	-		5 mm (11,8…12,7 N)
Deflection of the V-belt drive of the cooling system pump and alternator (at thrust force)	10…15 mm (78 N)	10…15 mm (100 N)	15 mm (50 N)
Static ignition advance angle before GM	7…9 °	9…11 °	-
Static angle of start of fuel delivery before GM	-		12 °
Range of automatic advance angle adjustment for the ejection angle	-		12° crankshaft angle of rotation
Fuel injection pressure	-		14,5…15,5 MPa
Interrupter contact spacing	0,35...0,45 mm or contact-free ignition	contact-free ignition	-
Short-circuit angle of the interrupter contacts	61…69 mm or contact-free ignition	contact-free ignition	-
Spark plug electrodes spacing	0,6…0,7 mm, and for contact-free ignition 0,8...0,9 mm		-
Idle speed	600…800 rpm	800…900 rpm	700 rpm
Idle travel of the clutch pedal	20…30 mm	20…30 mm	20…30 mm

1.5 ESSENTIAL CONTROL AND REGULATORY DATA OF THE VEHICLE

Idle travel of the clutch pedal (suspended version)	25…30 mm	-	25…30 mm
Idle steering wheel movement (measured at periphery)	40 mm maximum		
Looseness at the lower end of the intermediate lever of the drawback mechanism	0,5…1,0 mm		
Wheel alignment	1,5 … 3,00 mm		
Angle of wheel camber	$0°^{+45'}_{-20'}$		
Advance angle of the steering kingpin	6°		
Maximum steering angle	30°		
Turn-away diameter	12,6 m		
Idle travel of brake pedal (old design)	10 … 20 mm		
Idle travel of brake pedal (suspended version)	3 … 15 mm		
Tyre pressure: a) for varieties A062, A111, A161, A17, A151 and derivatives - front - rear b) for other varieties - front - rear	0,23 MPa 0,36 MPa 0,25 MPa 0,32 MPa		

1.7. Table: ŻUK ESSENTIAL CONTROL AND REGULATORY DATA

Container or system	dm^3
Fuel tank	55
Engine cooling system (with heaters) - S-21 - 4C90 - CB	12 12 8,5
Engine lubrication system - S-21 - 4C90 - CB	5,0 6,0 4,4
Lubrication system: - injection pump type PP4Me (MOTORPAL) - fuel injection angle adjuster	0,14 0,25
Gearbox: - 16 - A13.1 - Polonaise	1,1 1,2 1,55
Rear axle 18 (23) Rear axle 3005 (3015)	1,1 1,9
Steering transmission	0,33
Hydraulic brake system	0,4
Windscreen washer reservoir	2
Front wheel hubs	125 g each
Rear-wheel semi-axle bearings (B, C, D, F, G only)	100 g each
Battery 6SC45 Battery 6SE6OMN	2,6 5,0

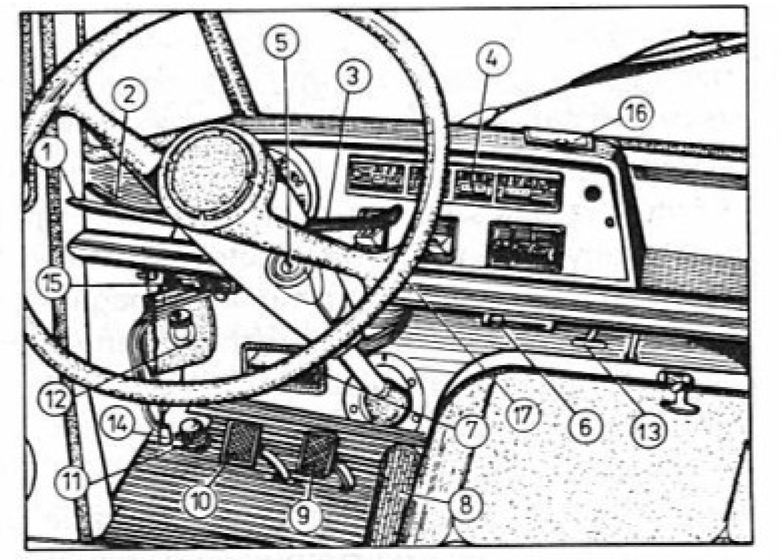
1.8. Table: CAPACITY OF TANKS, SYSTEMS AND ASSEMBLIES

1.6 CONTROL AND COMMAND SYSTEM

Driving mechanisms, located in the car within reach of the driver's seat, are shown in Figures 1.17 and 1.18.

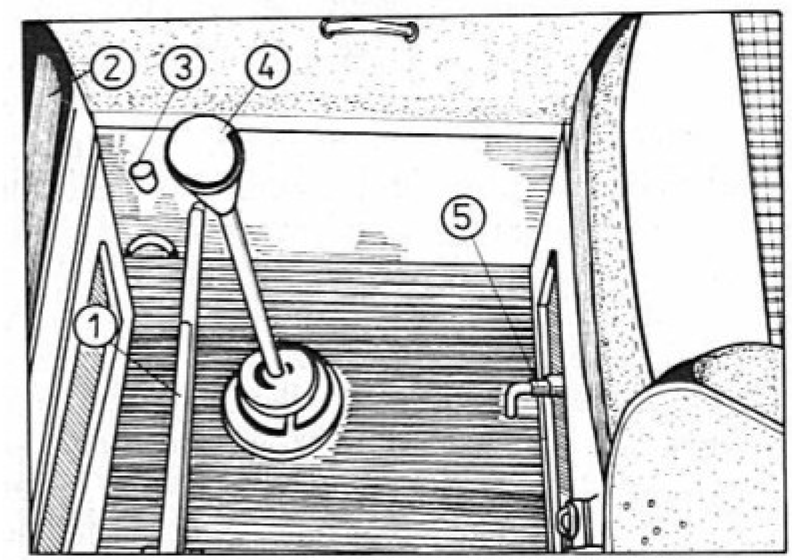
- The steering wheel is located on the left side of the cab. The steering arms shall be horizontal when the steered wheels are in the straight-ahead position. The turn of the wheels from one end position to the other corresponds to 3.5 turns of the steering wheel.
- The ignition switch (5, Fig. 1.17) is located on the right hand side of the steering column. A switch with a locked steering shaft is used in Zuk cars. The locked switch (Fig. 1.19) has four key positions: GAR - all consumers switched off (the key can be inserted or removed) powered by a switch, GO - ignition on, live consumers, START - starter switched on (after starting the engine the key automatically returns to the GO position), ST - after removing the key, the bolt locking the upper steering shaft is pulled out.

1.6 CONTROL AND COMMAND SYSTEM



1 - main light and light signal switch lever. 2 - direction indicator switch lever, 3 - windscreen wiper switch lever. 4 - indicator panel, 5 - ignition switch. 6 - control lever for cabin heating valve. 7 - harbour for hot air blowing. 8 accelerator pedal, 9 brake pedal, 10 clutch pedal, 11 windscreen washer pump footswitch, 12 windscreen washer fluid reservoir. 13 - string for opening the front cover lock of the cab, 14 - string for the radiator shutter, 15 - receiver's mounting socket. 16 - ashtray, 17 - steering wheel

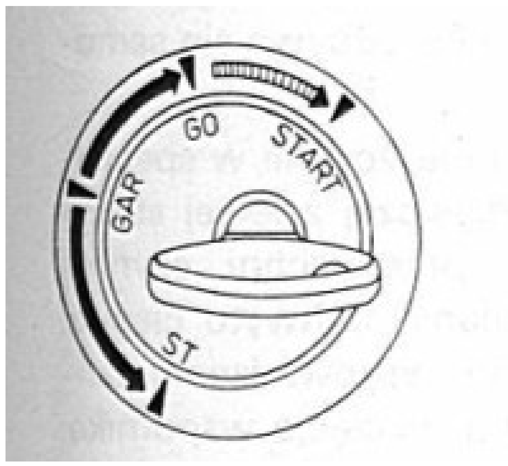
1.17. Figure: CONTROLS



1 - emergency brake lever (parking brake),
2 - driver's seat,
3 - tendon handle for carburetor starter or injection pump shutoff device “STOP",
4 - gearshift lever,
5 - battery switch

1.18. Figure: OTHER CONTROL EQUIPMENT

GAR - all receivers are turned off,
GO - Ignition beam,
START - starter switched on,
ST - stop.

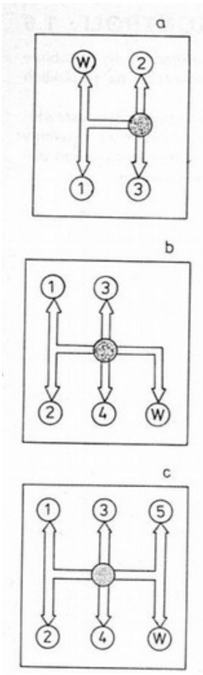


1.19. Figure: POSITIONING OF THE IGNITION KEY IN THE IGNITION LOCK ON THE STEERING SHAFT

- The gear lever (4, Fig. 1.18) is located in the side cover of the gearbox and passes through a hole in the floor to the right of the driver's seat. A diagram of the gear shift is shown in Fig. 1.20.
- The battery disconnector (5, Fig. 1.18) has two lever positions: the battery is connected to the electrical system by turning it clockwise and the battery is disconnected in the opposite direction. The disconnector is located on the left side of the passenger seat base.

- The emergency brake lever (1, Fig. 1.18) is located between the driver's seat and the gear lever. Pulling the lever handle up causes the brake to be applied. Release the handle by pressing the button at the top of the handle and lowering the handle.
- The pedal controlling the carburetor damper or the injection pump control bar (8, Figure 1.17) is located in the floor near the engine cover. Pedal depression increases the engine speed, release - decreases the engine speed.
- The clutch pedal (10, Fig. 1.17) is located in the floor, near the left wall of the cab, in a suspended version on a bracket attached to the front panel of the cab. Pressing the pedal will disconnect the clutch (drive) and release the clutch (drive).
- The brake pedal (9, Fig. 1.17) is located in the floor between the accelerator and clutch pedals, suspended on a support attached to the cab front panel. Pedal depression activates the service brake assist mechamism and increases the wheel braking torque proportional to the contact force. With the brake system correctly adjusted, the operating stroke of the pedal shall be half of the maximum stroke.

a - gearbox 16, b - gearbox A13.1 (four-speed gearbox FSO Polonaise), C - five-speed gearbox FSO Polonaise.



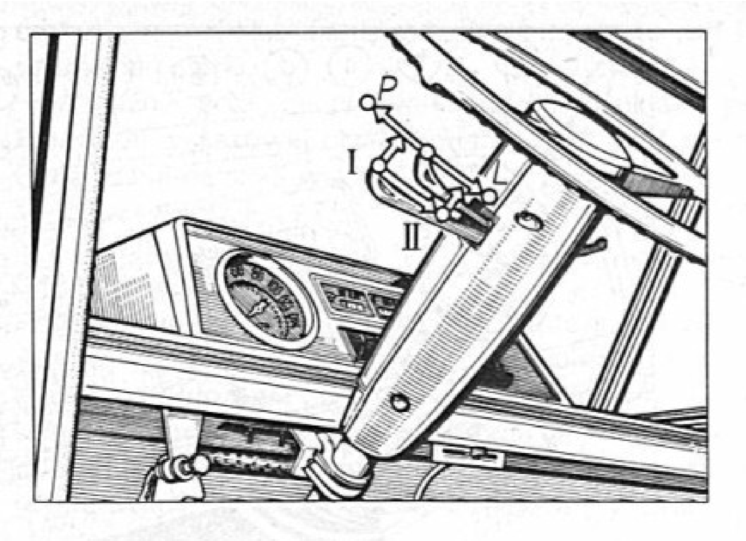
1.20. Figure: GEAR SHIFT DIAGRAMS

- The windscreen washer pump (11, Fig. 1.17) is located on the left side of the clutch pedal. In the first phase, the wiper circuit controlled by the handlebar lever is disconnected from the button (3, Fig. 1.17), in the second phase, the wiper liquid is pumped into the washers, and in the third phase, the wiper motor circuit is connected by the activation of the wipers. The pump is supplied with liquid from a two litre tank (12, Fig. 1.17) suspended on the left side of the cabin. The delivery rate for each pump stroke is 1.5...2.0 cm.
- The control lever for the heating valve (6, Fig. 1.17) is located under the dashboard shelf, on the right-hand side of the steering column. Moving the lever to the right extreme position opens the valve and directs the hot liquid to the heaters, located behind the front bulkhead on the left and right side of the cabin. If the lever is moved to the left position, the valve closes gradually until it closes completely. Fans are built into the heater housings to pump air through the heaters, increasing the intensity of the airflow to the glass, driver's and passenger's legs. Additional airflow regulation is achieved by tilting the airbag screen (7, Fig. 1.17) onto the legs and adjusting the lever located at the outlets of the airbag to the glass pane.
- Pull the rod handle of the front cover latch (13, Fig. 1.17) together to release the latch from the latch. When the cover is opened, press the handle down. The lock is automatically locked again when the lid is lowered.
- The radiator shutter control (14, Fig. 1.17) is located in a special bracket, which is attached to the dashboard on the left side of the driver's cab. Exposing or shading the active surface of the radiator is done by pulling or releasing the tendon handle. The position of the radiator

shutter-plate is determined by inserting the chain with which the string is ended into the special cut-out of the bracket. By selecting the correct aperture position, the driver can ensure that the engine operates in the optimum temperature range.

- The integrated switch head, located under the steering wheel, has three ring lever switches: - headlamps and light signals, - direction indicator lamps, - wipers and audible signals. A diagram of the switching arrangements of the headlamps and the direction-indicators is shown in Figure 1.21.

I – low beam,
II - main beam,
P - right direction indicator,
L - left direction indicator



1.21. Figure: CONTROL DIAGRAM FOR HEADLAMP AND DIRECTION-INDICATOR SWITCHES

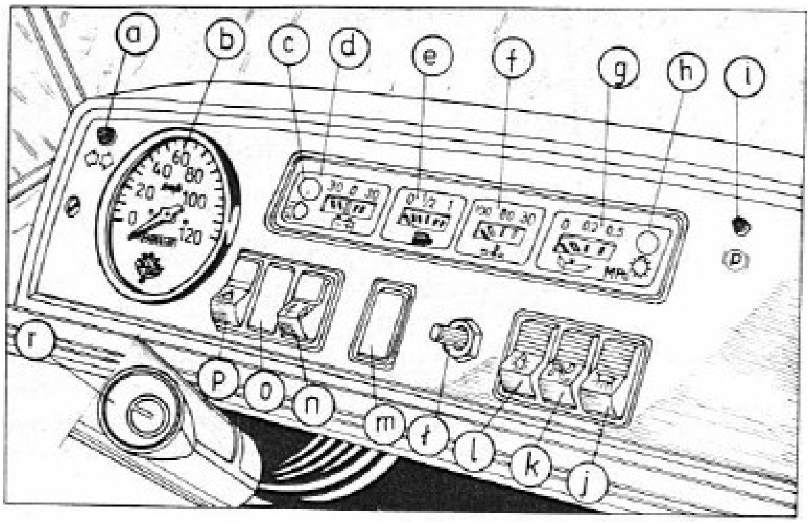
- The lever of the headlamp switch (1, Fig. 1.17) has two positions: | - the dipped-beam headlamp, 11 - the main-beam headlamp. The lights are switched on when the key switch (I, Fig. 1.22) on the indicator board is pressed into the second position, and the switch is switched off when the lever is moved from position I to II or vice versa. In position I, with switch (1) switched on, or in both positions 1 and||, with switch (1) switched off, and pulling the lever of the headlamp switch towards the steering wheel, the light signal (momentary switching on of the main beam) is activated.
- Direction indicator switch lever (2, Fig. 1.17) has three positions: central - direction indicators do not work, P - right, L – left.
- The wiper and tone selector lever (3, Fig. 1.17) has two positions: 1 - the wiper is off (position shown in Figure 1.21), 11 - the wiper is on (lever clockwise as far as it will go). In both positions, an audible signal is activated by pulling the lever towards the steering wheel.

The dashboards for all car models are shown in Figures 1.22...1.24. The dashboards differ by an additional set of key switches and control lamps for rear fog lamps (s, Figure 1.24) and flash lamps (t, Figure 1.24). Use the specific switches as follows:

  - To switch on the headlamps (Illuminative position), first operate the position (I) lamps by pressing the button (1),
  - the fog lamps must be lit when the key (n) is pressed and the position lamps must first be lit,

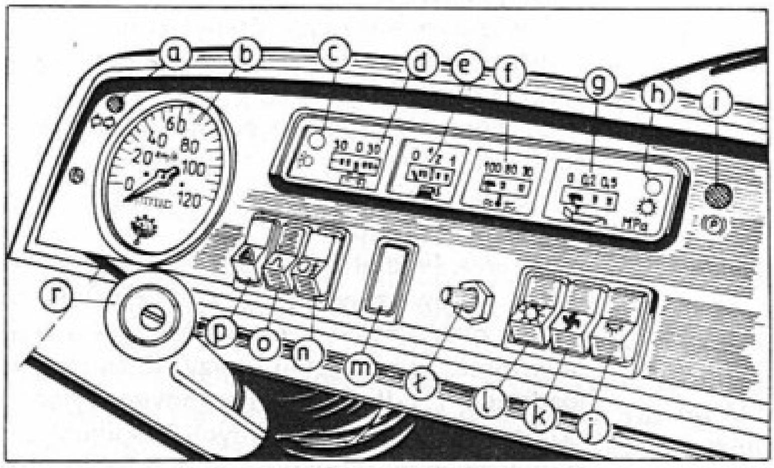
- after pressing the key (o) the flash (warning light) is switched on and after pressing the keys (o) and (m) the flash and the two-tone signal are switched on (Fig. 1.24).

The following indicators shall be included in the set of indicators, which shall be illuminated by two 2 Watt light bulbs each.



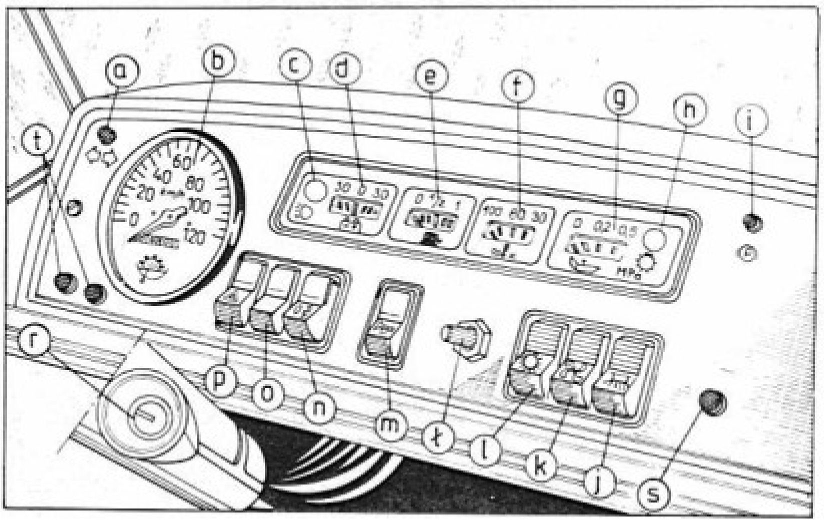
1.22. Figure: DASHBOARD FOR VERSIONS B, C, F, G, H

a - direction indicator lamp (green),
b - speedometer with odometer,
c - main-beam headlamp tell-tale (blue).
d - charging current indicator,
e - fuel level indicator in the pool.
f - Coolant temperature indicator.
g - engine oil pressure gauge,
h - position lamp tell-tale (green),
i - indicator light for brake lining service failure or parking brake application (red),
j - car interior lighting switch,
k - fan switch for heating and ventilation of the cabin,
l - switch of external lights: main and position - adjustment of the illumination intensity of the indicator board,
m - spare socket,
n - rear fog light switch (illuminated yellow).
o - spare socket,
p - the hazard warning signal switch (illuminated, red).
r - ignition switch



1.23. Figure: DASHBOARD FOR VERSIONS D, I

Symbols as in Ill. 1.22 and
o - Glow plug switch



1.24. Figure: DASHBOARD IN SPECIAL VERSION

Symbols as in Ill. 1.22 and
m - switch of two-tone signals or auto alarm,
o - Flashlight switch or engine start lock.
s- a control lamp for the fog lights,
t - Flash lamp tell-tale

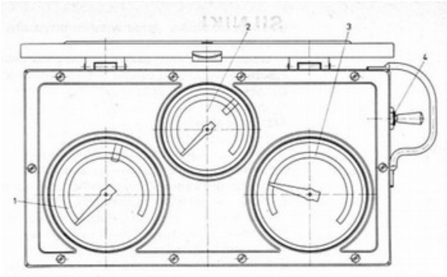
- Oil pressure gauge in the engine lubrication system (g,

Fig. 1.22), marked in MPa. If the display is in red, there is no pressure in the circuit and it is a signal to stop the vehicle immediately and correct the fault. If you continue to drive with a lack of pressure, the engine may run the risk of blurring.

- The liquid temperature indicator in the engine cooling system (f, Fig. 1.22) is displayed in C. The motor achieves optimum operating conditions in the temperature range 80°C to 90°C. Moving the pointer out of this range (red field) means that the temperature of the cooling liquid (overheating of the motor) increases excessively, which can cause serious damage to the motor. In this case, driving is not advisable until the fault has been remedied.
- Fuel level indicator in the supply system tank (e, Fig. 1.22). The position of the handbook indicates the approximate amount of fuel. The markings on the scale indicate: 1- full tank, 1/2 - half tank, 0 - no fuel in tank.
- Battery charging current indicator (d, Fig. 1.22) marked in A. If the alternator charges the battery, the pointer swings to the right of the "0" position. If the current consumption of the consumers is high and the alternator does not cover the demand or the battery is discharged when any of the consumers is switched on while the engine is stationary, the ammeter's pointer points to the left of the "0" position.
- A speedometer with a kilometer counter (b, Fig. 1.22) indicates speed in km/h and mileage in km. The range of the speed scale shall be 0 to 120 km/h and the range of the kilometer counter shall be 0 to 99999 km, after which the measurement of the mileage shall automatically start from zero. The speedometer disc is illuminated. In all vehicles, the direction indicator lamps are installed in the upper left corner of the instrument panel (a, Figure 1.22) and in the upper right the parking brake control lamp and the service brake circuit failure indicator (i, Figure 1.22), or, in the case of the version with suspended pedals, the brake fluid loss in the reservoir. In fire-fighting vehicles, in the lower left corner there are also installed warning light control lamps (t, Fig. 1.24), in the lower right
- the rear fog lamp control lamp (s, Fig. 1.24). The Color of the tell-tale lamp shall be green, that of the emergency brake shall be red and that of the warning and fog-lamp shall be yellow. All lamps, except those for the exterior and main-beam headlamps which are switched off, shall have an adjustable luminous intensity by turning the exterior cover. A151 car is equipped with A2/12 auto-pump (Fig. 1.25). The operation of the auto-pump is controlled by a set of indicators (Fig. 1.26) placed in a separate box mounted above the auto-pump. The purpose of the indicators is as follows:
    - The pressure gauge (1, Fig. 1.26) indicates the discharge pressure generated by the auto-pump (maximum 1.2 MPa),
    - The MS-2 tachometer (2, Fig. 1.26) indicates the current engine speed (recommended operating range 2900 to 3000 rpm).
    - The manometer (3, Fig. 1.26) indicates the suction depression generated at the inlet to the autopump (range from 0,05 to 0,15 MPa). The self-pump is driven from the car engine by an electromagnetic clutch. The auto-pump's rotational speed is adjusted by

changing the motor's rotational speed with a knob attached to the upper crossbar of the air inlet grate's frame.

1.26. Figure: A151 - FIRE TRUCK PUMP SUPPORT



1.25. Figure: FIRE TRUCK PUMP DISPLAY A2/12

1 - pressure gauge, 2 - tachometer, 3 - manometer, 4 - switch for the electromagnetic coupling of the auto-pump

2 ENGINES

S-21 and CB carburetor engines and 4C90 compression-ignition engines are used for the propulsion of Żuk vehicles and are described in chapters 2.1, 2.2 and 2.3 for their design, operation and repair

2.1 S-21 ENGINE

The S-21 engine is an uppervalve carburetor engine. The technical characteristics of this engine are given in Table 2-1 and the external view and fittings are shown in Figure 2.1.

The external dimensions of the engine (length x width x height) are as follows: 816 x 575 x 727.5 mm (motor length supplied with clutch housing).

On the left side of the engine (viewed in the direction of travel) are the alternator, the ignition distributor and the spark plugs, starter, oil filter, oil level gauge, coolant drain valve from the engine hull and thermostat; on the right side there are: suction and exhaust pipe, gas pipe and fuel and oil pump.

The cross-sections (Fig. 2.2) and the longitudinal sections (Fig. 2.3) show the internal structure of the motor. The external characteristics of the run-in S-21 engine, i.e. the graphs of power (N_e), torque (M_o) and specific fuel consumption (g_e) as a function of the rotational speed, are shown in Figure 2.4.

The most favorable operating range of the engine is between the speed of the maximum torque (2500 rpm) and the maximum power (4000 rpm). This engine, which is not an exerted unit (24.3 kW/dm^3), has a long service life.

2.1.1 S-21 Hull

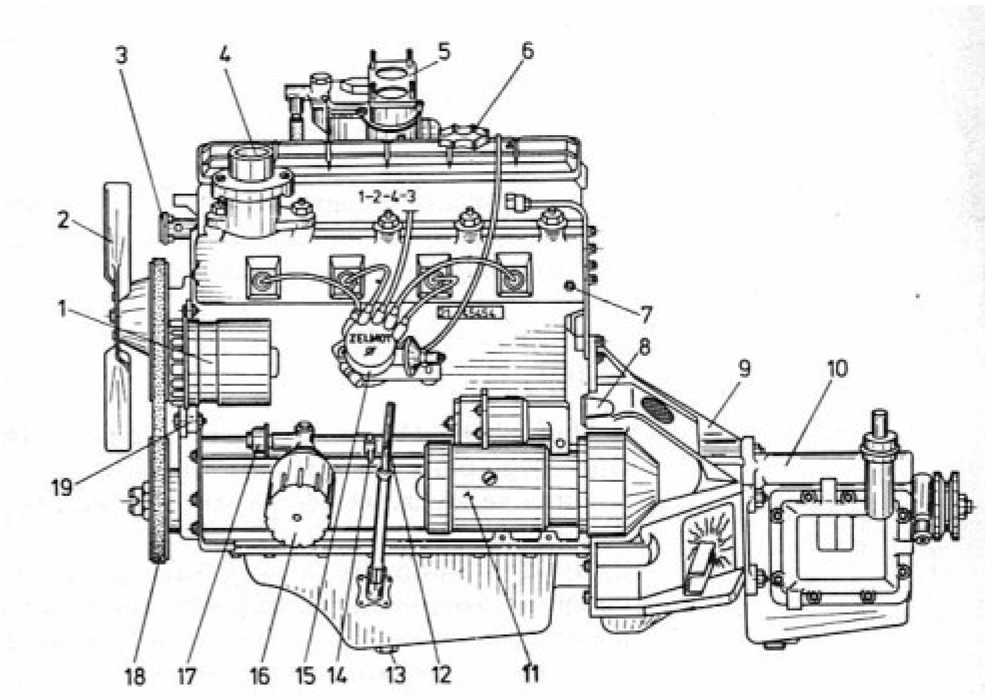
The engine hull (1, Figure 2.2) is a uniform grey cast iron casting. The upper part is a block of cylinders.

Cylinders are produced in two basic dimension groups: $81{,}88^{+0{,}66}_{+0{,}06}$ mm and $82{,}12^{+0{,}066}_{+0{,}006}$ mm and selected (Tables 2-2 and 2-3). The selection group mark of each cylinder is punched on the cylinder block headplate on the pushrod side as shown in Figure 2.5. This makes it easy to select the pistons for the cylinders and maintain the required fit.

Type	exhaust gas, piston
Type of fuel	gasoline octane 86 LO/B
Number of stroke strokes	4
Number of cylinders	4
Arrangement of cylinders	in-line
Cylinder diameter	82 mm
Piston stroke	100 mm
Spare volume	2,12 dm^3
Compression ratio	7,5
Maximum power (in compliance with DIN)	51,5 kW
Maximum power speed	4000 rpm
Maximum torque	147 N·m
Maximum torque speed	2500 rpm
Engine suspension	three-point attachment to the frame above the front axle

Camshaft mechanism:	
Number of valves	
- suckers	4
- exhaust	4
Valve arrangement	overhead (OHV)
Arrangement of camshaft	cam-in-block
Valvetrain drive	timing gears
Ignition sequence	1-2-4-3
Power supply:	
fuel pump	mechanical diaphragm
carburetor	28/35S2A1 or 28/35S2B1
air filter	dry
Lubrication system:	circulating
oil pump	sprocket
oil filter	serial, full flow
Crankcase venting system	encapsulated
Cooling system:	with forced fluid circulation
cooling system pump	rotor
radiator	tubular belt
ventilator	fourfold
Exhaust system	with one exhalation silencer

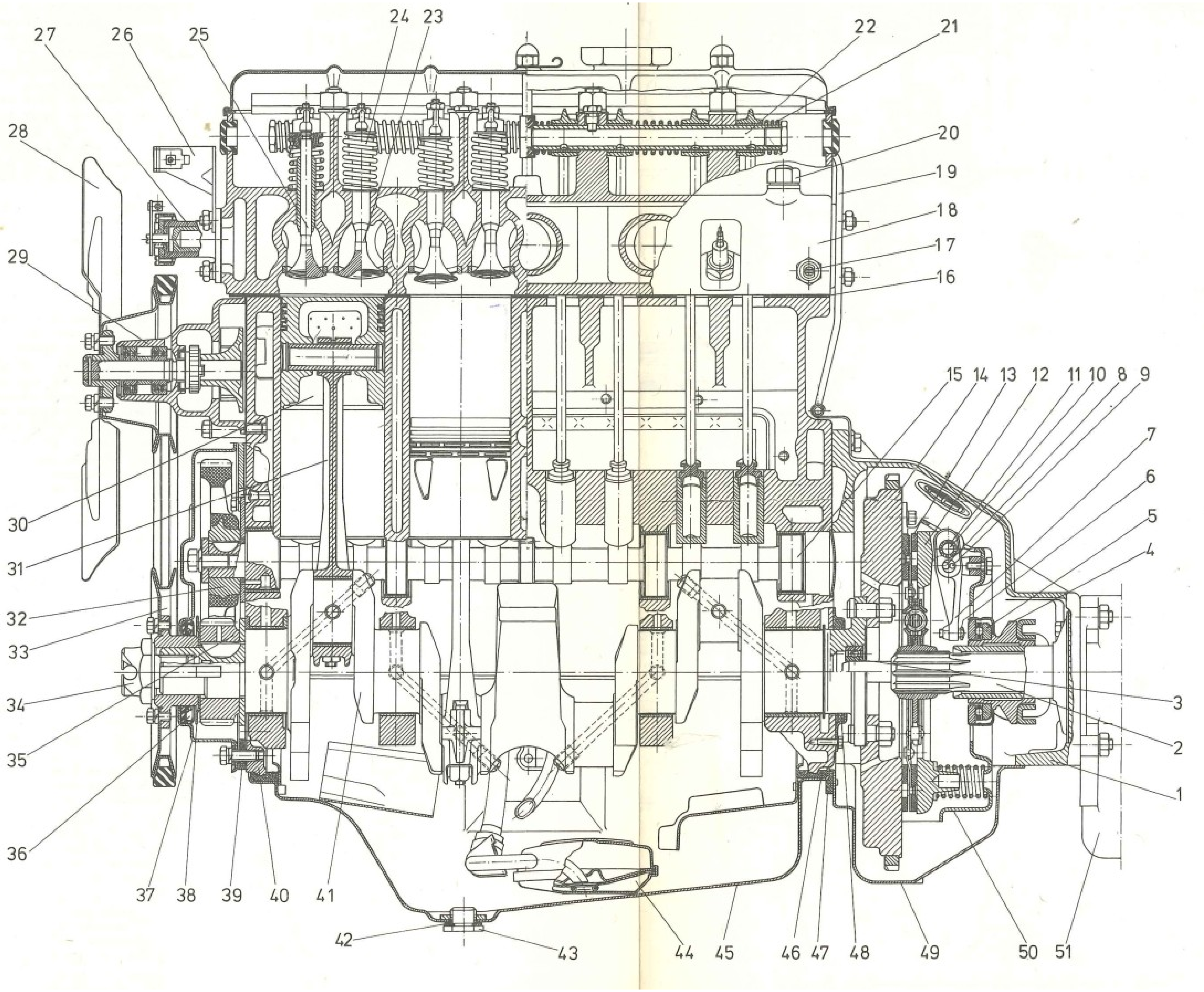
2.1. Table: TECHNICAL CHARACTERISTICS OF THE ENGINE S-21



2.1. Figure: S-21 ENGINE - EXTERNAL VIEW

1 - alternator, 2 - fan, 3 - cabin heating valve, 4 - thermostat, 5 - carburettor, 6 - oil filler cap, 7 - coolant temperature sensor. 8 - sight glass, 9 - clutch, 10 - gearbox, 11 - starter. 12 - oil level gauge, 13 - oil drain plug. 14 - coolant drain plug. 15 - ignition distributor, 16 - oil filter. 17 - oil pressure sensor. 18 - V-belt drive of the cooling system pump. 19 - alternator bracket

1 - alternator, 2 - wentylator, 3 - zawór układu ogrzewania kabiny, 4 - termostat, 5 - gaźnik, 6 - korek wlewu oleju, 7 - czujnik temperatury cieczy chłodzącej. 8 - wziernik, 9 - sprzęgło, 10 - skrzynka biegów, 11 - rozrusznik. 12 - miarka poziomu oleju, 13 - korek spustowy oleju. 14 - korek spustowy cieczy chłodzącej. 15 - rozdzielacz zaplonu, 16 - filtr oleju. 17 - czujnik ciśnienia oleju. 18 - pasek klinowy napędu pompy układu chłodzenia. 19 - wspornik alternatora

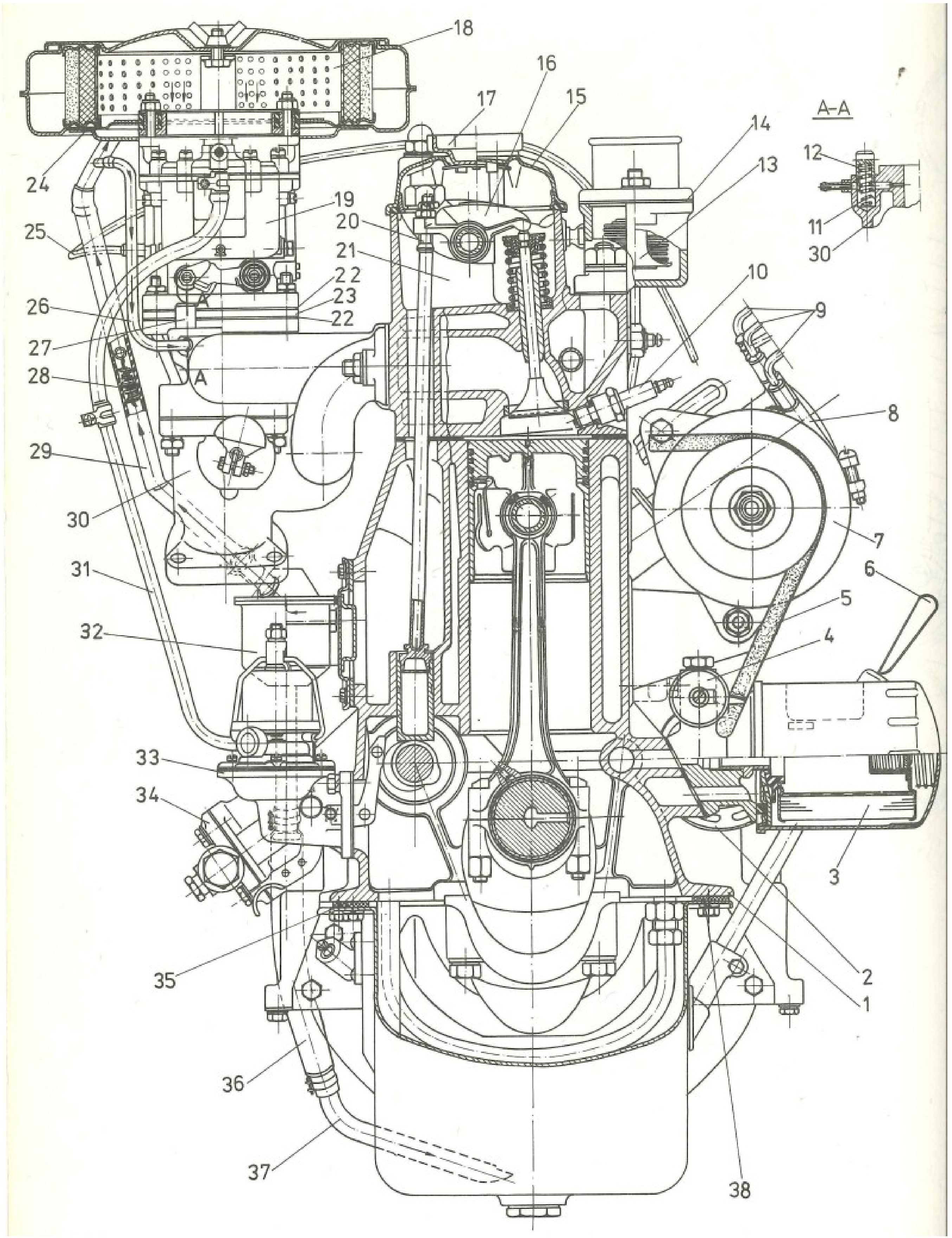


1 - engine hull, 2 - starter, 3 - full oil filter, 4 - oil pressure sensor, 5 - drive belt for cooling system, fan and alternator pump, 6 - oil level gauge, 7 - alternator, 8 - ignition distributor, 9 - high-voltage cables, 10 - spark plug, 11 - crankcase gas extraction valve spring, 12 - crankcase gas extraction valve piston, 13 - thermostat, 14 - thermostat casing, 15 - head cap, 16 - valve lever, 17 - oil filler cap,
18 - air filter insert, 19 - carburettor 28/35SA1, 20 - valve lever adjustment screw, 21 - pusher rod, 22 - carburetor gasket, 23 - carburetor insulation washer, 24 - air filter housing, 25 - ignition device vacuum regulator pipe, 26 - crankcase gas extraction valve pipe, 28 - flame damper, 29 - breather pipe - air filter, 30 - suction-exhaust pipe, 31 - fuel pipe - pump - spool, 32 - breather, 33 - fuel pump, 34 - oil pump, 35, 38 - oil sump gaskets, 36 - oil drainage pipe from breather, 37 - oil drain pipe from breather.

1 - kadłub silnika, 2 - rozrusznik, 3 - pełnoprzepływowy filtr oleju, 4 - czujnik ciśnienia oleju, 5 - pasek klinowy napędu pompy układu chłodzenia, wentylatora i alternatora, 6 - miarka poziomu oleju, 7 - alternator, 8 - rozdzielacz zapłonu, 9 – przewody wysokiego napięcia, 10 - świeca zapłonowa, 11 - sprężyna zaworu odsysania gazów ze skrzyni korbowej, 12 - tłoczek zaworu odsysania gazów ze skrzyni korbowej, 13 - termostat, 14 - obudowa termostatu, 15 - pokrywa głowicy, 16 - dźwignia zaworu, 17- korek wlewu oleju,
18 - wkład filtru powietrza, 19 - gaźnik 28/35SA1, 20 - wkręt regulacyjny dźwigni zaworu, 21 – drążek popychacza, 22 - uszczelka gaźnika, 23 - podkładka izolacyjna gaźnika, 24 - obudowa filtru powietrza, 25 - przewód podciśnieniowego regulatora aparatu zapłonowego, 26 - przewód zaworu odsysania gazów ze skrzyni korbowej, 28 - tłumik płomieni, 29 - przewód odpowietrznik - filtr powietrza, 30 - przewód ssąco-wydechowy, 31 - przewód paliwa pompa-gaźnik, 32 - odpowietrznik, 33 - pompa paliwa, 34 - pompa oleju, 35, 38 - uszczelki miski olejowej, 36 - przewod spływu oleju z odpowietrznika, 37 - rurka spływu oleju z odpowietrznika

2.2. Figure: S-21 ENGINE - CROSS-SECTION

2.1.1 S-21 Hull



2.3. Figure: S-21 ENGINE - LONGITUDINAL SECTION

1 - clutch housing, 2 - gearbox clutch shaft, 3 - clutch shaft bearing, 4 - clutch press bearing sleeve, 5 - clutch press bearing, 6 - adjusting screw, 7 - switch lever, 8 - lever pin (truncated), 9 - roller, 10 - lever pin, 11 - needle roller bearing, 12 - pressure ring, 13 - clutch disc, 14 - flywheel, 15 - camshaft, 16 - head gasket, 17 - coolant temperature sensor, 18 - head, 19 - oil pipe for valve lever axis, 20 - head fixing nut, 21 - valve lever spreader spring, 22 - valve lever axis, 23 - suction valve, 24 - valve spring, 25 - exhaust valve, 26 - heating valve rod bracket, 27 - cabin heating valve, 28 - fan, 29 - cooling system pump, 30 - piston, 31 - crankshaft, 32 - camshaft gear, 33 - cooling system pump drive pulley, 34 - crank gear clutch, 35 - crankshaft gear drive gear, 36 - crankshaft front seal, 37 - camshaft drive cover, 38 - oil jet, 39 - engine front disc, 40 - oil sump seal half-ring, 41 - crankshaft, 42 - oil drain plug gasket, 43 - oil drain plug, 44 - oil pump drag, 45 - oil sump, 46 - oil sump gasket, 47 - clutch guard gasket, 48 - crankshaft rear bearing gasket, 49 - coupling sleeve

1 - obudowa sprzęgła, 2 - walek sprzęgłowy skrzynki biegów, 3 - łożysko wałka sprzęgłowego, 4 – tuleja łożyska wyciskowego sprzęgła, 5 - łożysko wyciskowe sprzęgła, 6 - śruba regulacyjna, 7 – dźwigienka wyłączająca, 8 - sworzeń dźwigienki (ścięty), 9 - rolka, 10 - sworzeń dźwigienki, 11 - łożysko igiełkowe, 12 - pierścień dociskowy, 13 - tarcza sprzęgła, 14 - koło zamachowe, 15 – wał rozrządu, 16 - uszczelka głowicy, 17 - czujnik temperatury cieczy chłodzącej, 18 - głowica, 19 - przewód oleju osi dźwigni zaworów, 20 - nakrętka mocowania głowicy, 21 - sprężyna rozpierająca dźwignie zaworów, 22 - oś dźwigni zaworów, 23 - zawór ssący, 24 - sprężyna zaworu, 25 - zawór wydechowy, 26 - wspornik cięgna zaworu ogrzewania, 27 - zawór ogrzewania kabiny, 28 - wentylator, 29 - pompa układu chłodzenia, 30 - tłok, 31 - korbowód, 32 - koło zębate wału rozrządu, 33 - koło pasowe napędu pompy układu chłodzenia, 34 - zazębiacz korby rozruchowej, 35 - koło zębate napędu wału rozrządu, 36 - uszczelniacz przedni wału korbowego, 37 - pokrywa napędu rozrządu, 38 - odrzutnik oleju, 39 - tarcza przednia silnika, 40 - półpierścień przedniej uszczelki miski olejowej, 41 - wał korbowy, 42 - uszczelka korka spustowego oleju, 43 - korek spustowy oleju, 44 - smok pompy oleju, 45 - miska olejowa, 46 - uszczelka miski olejowej, 47 - uszczelka osłony sprzęgła, 48 - gniazdo uszczelniacza tylnego łożyska wału korbowego, 49 - osłona sprz

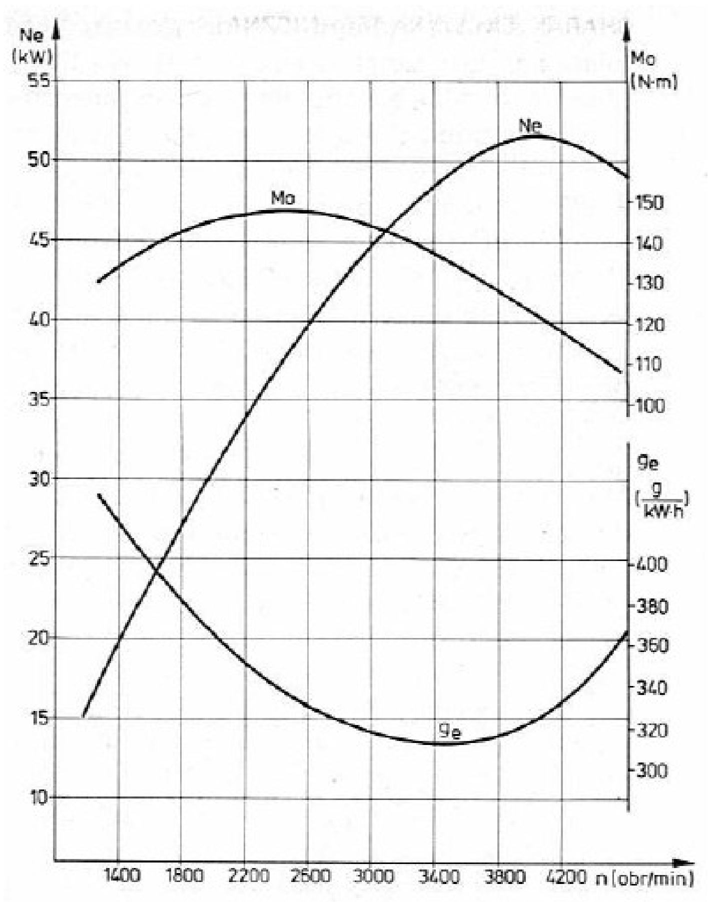
2.1.1 S-21 Hull

Group designation	Cylinder diameter, mm
A	81,886…81,898
B	81,898…81,910
C	81,910…81,922
D	81,922…81,934
E	81,934…81,946

2.2. Table: SELECTION GROUPS FOR CYLINDERS OF THE FIRST DIMENSION GROUP ($81,88^{+0,066}_{+0,006}$ mm)

Group designation	Cylinder diameter, mm
S	82,126…82,138
T	82,138…82,150
U	82,150…82,162
W	82,162…82,174
Z	82,174…82,186

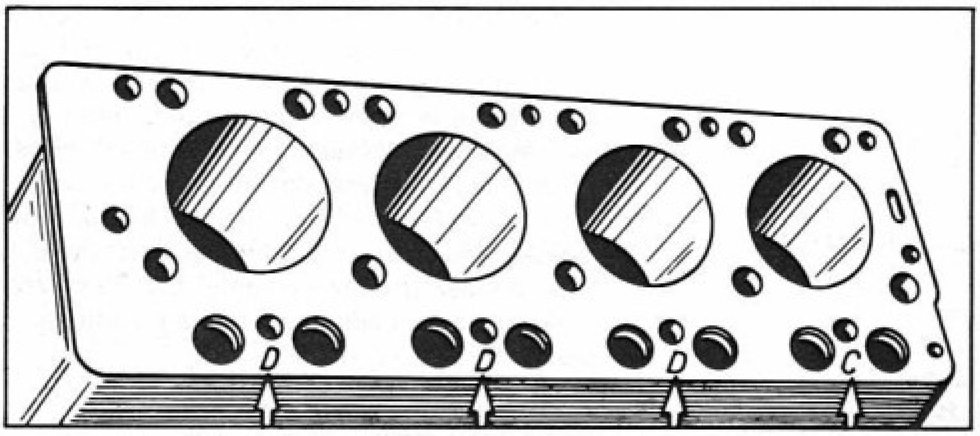
2.3. Table: SELECTION GROUPS FOR CYLINDERS OF THE SECOND DIMENSION GROUP ($82,12^{+0,066}_{+0,006}$ mm)



2.4 Figure: S-21 EXTERNAL CHARACTERISTICS

2.1.1 S-21 Hull

The cylinder axes are shifted 3 mm from the main bearing axis of the crankshaft (in the direction of the camshaft bearings). This reduces the pressure of the pistons on the cylinder liners during operation, reduces wear and tear and reduces noise levels.

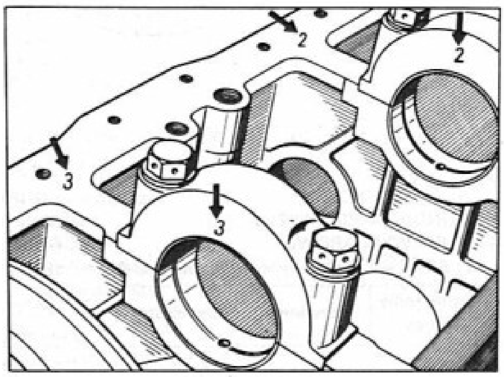


2.5. Figure: PLACE OF MARKING OF CYLINDERS SELECTION GROUP

The hull of an engine of which the cylinders are made in the second dimension group shall be marked with an additional letter C, minced after the engine production number. Other letters here indicate:

- E - engine corresponding to the special export conditions,
- G - crankshaft motor whose main pivots are $63{,}75_{-0{,}013}$ mm in diameter and $51{,}5_{-0{,}013}$ mm in crankshaft diameter,
- K - crankshaft motor whose main pivots are $64{,}0_{-0{,}013}$ mm in diameter and $51{,}25_{-0{,}013}$ mm in crankshaft diameter.

The lower part of the hull casting is made up of the crankcase housing, also known as the crankcase. It has four crankshaft main bearing seats in ribbed walls that extend from the top to the bottom plate of the cylinder block. These sockets are broken down. The cast iron covers of the main bearings (each bolted with two M14 × 75 screws) are machined to a dimension of $68{,}5^{+0{,}018}$ mm. Since the covers of the two center bearings are the same, they are marked with the numbers "2" and "3" respectively (for identification purposes). The marking position of the main bearing covers and the hull are shown in Figure 2.6. The lower crankcase plate is used to bolt on the oil sump.



2.6. Figure: THE LOCATION WHERE THE MAIN BEARING COVERS ARE MARKED

In the supporting walls, on the right side of the crankcase, there are four Sunday camshaft bearing seats. Bearing bushings made of bimetallic low-tin tape have the following diameters: first 52 mm, second 51 mm, third 50 mm, fourth 48 mm (tolerance +0,025... 0,050 mm), which allows the camshaft to be mounted from the front of the engine. Above the camshaft, there are eight tappet guides in the lower plate of the cylinder block

(next to the water jacket). Above them there is a pusher chamber. The $25^{+0,033}$ mm diameter guides are selected and Color-coded as shown in Table 2-4.

Color of the group designation	Guide diameter, mm
Blue	25,000…25,011
Yellow	25,011…25,022
White	25,022…25,033

2.4. Table: SELECTION GROUPS FOR TAPPET GUIDES

The crankcase support walls are equipped with oil channels to distribute the oil to the main bearings of the crankshaft and camshaft bearings. The clutch guard (after turning) also undergoes joint finishing with the hull. It is therefore marked on the header with the hull number with which it was worked together.

2.1.2 S-21 Head

The engine head (18, Figure 2.3) is a die-cast aluminium alloy. There are four combustion chambers at the bottom of the head plate, each with a volume of 70^{+2}_{-1} cm^3, with suction and exhaust ducts to the right of the head and threaded holes (M14x1,25) for the spark plugs on the left.

The inlet and exhaust ducts, on the combustion chamber side, have one press-in socket for the suction valve and one press-out outlet (alloy cast iron) after heating the head to 200°C, and two valve guides (grey cast iron) each.

The diameter of the outlet for the suction valve seat is $44^{+0,039}$ mm and for the exhaust valve seat is $41^{+0,039}$ mm. The diameter of the head holes in which the valve guides are seated is $16^{+0,018}$ mm. The walls of the combustion chambers and the suction and exhaust ducts are cooled by liquid circulating in the surrounding areas. In order to increase the cooling intensity of the exhaust ducts (higher operating temperature), a distribution tube is placed on their left side, which has drilled holes to direct the cooled liquid stream (directly from the cooling pump) to the outer duct walls. The cooling space of the head, connecting to the cooling space of the engine hull through the openings in the lower head plate and the upper hull, also has an outlet through the thermostat casing and thermostat (13, 14, Fig. 2.2) to the radiator and in the front wall through the heating system valve of the cabin (27, Fig. 2.3) to the heaters.

The head has a valve lever chamber at the top, closed from the top, through a cork gasket, with a cover (15, Fig. 2.2), fixed with three stud bolts and cap nuts.

On the right side of the chamber, holes are made for the tappet rods (21, Fig. 2.2), which control the valve levers (16, Fig. 2.2). These levers are pivoted on two axes (22, Fig. 2.3) seated in four head supports, with sockets of $21^{+0,033}$ mm diameter. For mounting the axle in the front and rear of the valve lever chamber, holes are made with rubber plugs.

On the left side of the chamber are cast numbers 1-2-4-3, which denote the ignition sequence of the mixture in individual cylinders (the sequence of cylinders' operation).

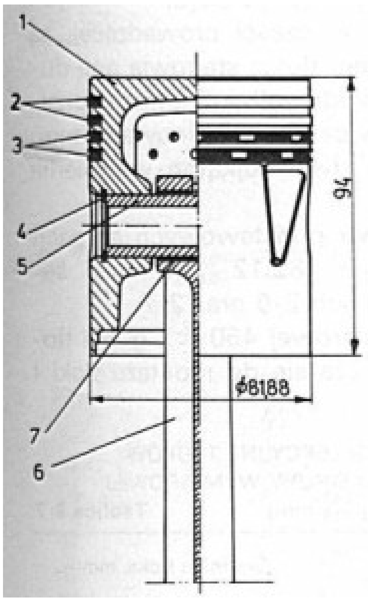
2.1.2 S-21 Head

The head is attached to the engine hull by means of an asbestos-knock gasket reinforced with a steel frame (16, Fig. 2.3) with eleven M14x2 bolts made of alloy steel, screwed into the upper plate of the engine hull.

2.1.3 S-21 Crankshaft piston mechanism

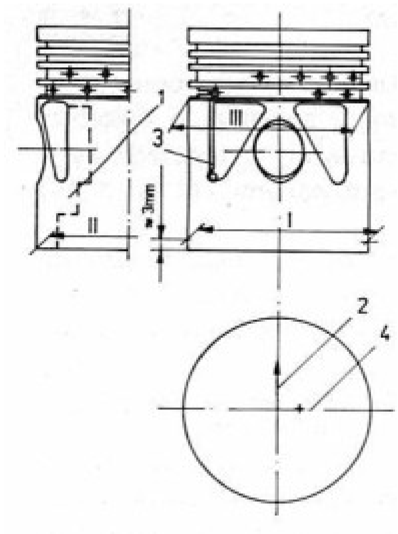
1 - piston,
2 - sealing rings,
3 - scraper rings,
4 - ring protecting the piston pin,
5 - piston pin,
6 - crank eye,
7 - crank eye sleeve.

1 - tłok,
2 - pierścienie uszczelniające,
3 - pierścienie zgarniające,
4 - pierścień zabezpieczający sworzeń tłokowy,
5 - sworzeń tłokowy,
6 - korbowód.
7 - tulejka główki korbowodu



2.7. Figure: COMPLETE PISTON WITH CONNECTING ROD

1 - place for marking the selection group of the pin hole (trout hub),
2 - arrow for setting the piston during installation,
3 - intersection of the background plating,



2.8. Figure: SHAPE AND LOCATION OF PISTON MARKINGS

The crankshaft mechanism consists of four pistons (30, 2.3), connecting rods (31, 2.3) and a crankshaft (41, 2.3). The crankshaft piston assembly kit (Fig. 2.7) includes:

- Piston 1 pcs.
- Crank ducting 1 pcs.
- Piston bolt 1 pcs.
- Safety ring piston pin 2 pcs.
- Piston rings (top and bottom) 2 pcs.
- Piston rings for scraping 2 pcs.

To complete the set, the following selection groups are selected in the same color: piston, pin and connecting rod. The pistons are heated to 70°C before assembly.

Ring	**Groove size, mm**	
	height	**bottom**
Upper sealing	2,460…2,480	72,45…72,70
Lower sealing	2,450…2,470	72,42…72,70
Scrapper	4,035…4,055	72,25…72,50

2.5. Table: DIMENSIONS OF THE GROOVES OF THE PISTON RINGS

■ The pistons are made of an aluminium silicon alloy. Each piston can be distinguished by the following elements:

- the bottom is a flat plate reinforced with ribs inside;
- the ring part (adjacent to the bottom) in which grooves are pressed into the piston rings (of the dimensions given in tables 2 to 5); in the grooves of the scraper rings there are 13 through holes of 3 mm diameter, drilled on the circumference, used to remove oil scraped off by the rings; the piston ring part is adjacent to the cylinder track only when the normal operating temperature of the engine has been reached;
- a guide part (called a jacket) which is fitted to the cylinder (when the pistons are assembled) with a clearance of 0.012...0.036 mm measured on the diameter ! (Fig. 2.8).

In order to reduce the play and noise, the piston rod guide part has:

- ovalisation of the equatorial section; the difference between diameters I and II is 0,290 ±0,040 mm, with diameter II (smaller) in the axis of the piston pin;
- a cone (base at the bottom); the difference between diameters I and III (in a plane perpendicular to the axis of the pin) is 0,025 mm;
- the trapezoidal intersections (3) on the unloaded piston side during stroke operation allow the coating to adhere elastically to the cylinder smooth surface all around (cold and hot); the horizontal part of the intersection is made in the groove of the lower scraper ring and is used as an opening for the drainage of the scraped oil.
- the piston rod hubs in the guide section are bounded by zebras to the ring section and the bottom of the piston; they form a high concentration of material which, if heated, would result in an excessive increase in diameter and a tendency to peel; two triangular compensation recesses are provided on each side of the hubs to eliminate this phenomenon.

Pistons, like cylinders, are made in two basic dimension groups I – 81,88 $^{+0,042}_{-0,018}$ mm and II – 82,12 $^{+0,042}_{-0,018}$ mm and selected according to the rules given in tables 2-6 and 2-7.

Pistons weight is: for pistons in dimension group I 450 ± 2 g, for pistons in dimension group II 455 ± 2 g. It is permissible to fit pistons of a reduced mass group up to 445 ± 2 g, these are marked on the inside inflows (below the pin hub) in blue and can only be used on all cylinders simultaneously on the same engine.

Group designation	Piston diameter, mm
A	81,862 … 81,874
B	81,874 … 81,886
C	81,886 … 81,898
D	81,898 … 81,910
E	81,910 … 81,922

2.6. Table: SELECTION GROUPS OF PISTONS OF THE FIRST DIMENSION GROUP (81,88 $^{+0,42}_{-0,018}$ mm)

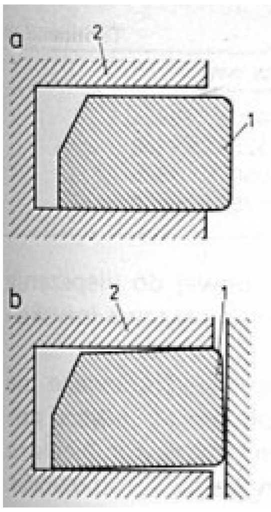
Group designation	Piston diameter, mm
S T U W Z	81,102…82,114 82,114…82,126 82,126…82,138 82,138…82,150 82,150…82,162

2.7. Table: SELECTION GROUPS OF PISTONS OF THE SECOND DIMENSION GROUP ($82{,}12^{+0{,}42}_{-0{,}018}$ mm)

The hub holes (nominal diameter 22 mm) are selected and marked in colors according to Table 2-8 to ensure adequate clearance with the piston bolt.

Color of the group designation	Diameter of hole, mm
Red	21,9900…21,9925
Yellow	21,9925…21,9950
Green	21,9950…21,9975
White	21,9975…22,000

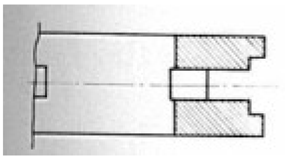
2.8. Table: SELECTION GROUPS FOR HOLES FOR PISTON BOLTS IN PISTON HUBS



a - after mounting on the background,
b - after mounting in the cylinder,

1 - sealing ring.
2 - background

2.9. Figure: PRINCIPLE OF COOPERATION BETWEEN SEALING CHEST AND CYLINDER



2.10. Figure: SECTION OF SCRAPER RING

■ Piston rings are used to seal the piston in the cylinder, to distribute the oil over the cylinder smoothness, while scraping off excess oil (so it does not penetrate into the combustion chambers) and to remove heat from the piston to the hull. They are made of gray cast iron with a special structure and chemical composition.

Sealing rings, 2,388…2,400 mm high, have a rectangular cross-section with an internal diagonal cut, the upper edge (Fig. 2.9a), and the scraping rings have a channel cross-section of 3,988…4,0 mm (Fig. 2.10). On the circumference of these rings are made through oil grooves, which drain excess oil to the internal space of the piston. The diagonal cut on the inner surface of the sealing rings and the height less than the groove width enable them to align diagonally in the ring groove

of the piston (Fig. 2.9b), increase the unit pressure on the smoothness (edge contact) and thus achieve a more accurate tightness. The prerequisite for this is that the rings are mounted correctly: the inner cuts towards the bottom of the piston.

The force required to compress the ring in a test gauge with a diameter of 81,88...81,915 mm (to obtain a gap in the lock of 0,2...0,45 mm) should be:

- sealing rings 18,6...26.5 N,
- scraper rings 15,7...21.6 N.

The cylindrical surface of the upper sealing ring is coated with porous chromium (0,1...0,15 mm thick) to extend the service life of the upper sealing ring and ensure its reliable operation under extreme conditions. In order to shorten the run-in time of the other piston rings, their external surfaces are tin-plated or phosphated (with a layer thickness of 0,0005...0,10 mm).

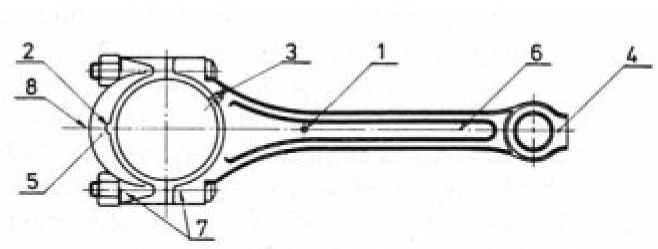
■ Piston pins connect the pistons to the crankshafts in an articulated manner. The S-21 engine uses a floating-type piston pin, fitted with a suitable fit in the crankshaft head and in the piston hubs (in combination with a crankshaft-pin for play of 0,0045...0,0095 mm and in combination a pin-pin for play of 0,0025...0,0025 mm). The pins are made of higher quality structural steel and are surface hardened at a depth of 1...1,5 mm. Piston pins (external diameter $22_{-0,010}$ mm), like the holes in the piston hubs, are selected into four groups and marked on the inside surface in colors according to Table 2-9. The pin weighs 112 ± 2 g. The piston rings are equipped with a piston rod and a piston rod. The pin is secured against sliding out of the piston by two circlips.

Color of the group designation	Pin diameter, mm
Red	21,9900…21,9925
Yellow	21,9925…21,9950
Green	21,9950…21,9975
White	21,9975…22,000

2.9. Table: SELECTION GROUPS OF PISTON PINS

■ The crankshafts (Fig. 2.11) are forgings of alloy steel for heat treatment. The bronze bushing of the piston rod bearing is pressed into the crankshaft head.

The bolt holes with a dimension of $22^{+0,007}_{-0,003}$ mm are selected into four selection groups (Table 2-10) and marked in colors at the point indicated by the arrow (6). At the top of the head there is a thickening, which removes excess material when balancing the crankshaft. A 3 mm wide groove is milled in this thickness to lubricate the mating surfaces of the piston pin and crankshaft bushing.



2.11. Figure: CRANK DUCK MARKING

1, 2 - shaft and cover alignment tabs, 3 - oil channels, 4 - crankshaft, 5 - crankshaft Iba cover, 6 - crankshaft marking with piston pin hole selection, 7 - crankshaft cover and shaft marking with 8 - crankshaft marking with total weight selection with respect to crankshaft marking.

1, 2 - występy określające wzajemne ustawienie trzonu i pokrywy, 3 - kanalek olejowy, 4 - korbowód, 5 - pokrywa Iba korbowodu, 6 - miejsce znakowania korbowodu grupą selekcyjną otworu na sworzeń tłokowy, 7 - miejsce znakowania pokrywy i trzonu korbowodu 8 - miejsce znakowania korbowodu grupą selekcyjną masy całkowitej.

2.1.3 S-21 Crankshaft piston mechanism

The stem of the crankshaft has an I-beam cross-section and high compressive, tensile and bending strength. The external surfaces of the shank are machined. The crankshaft head has a $55^{+0,010}$ mm diameter hole for the crankshaft shells and is screwed onto the cover with two special chrome-plated crankshaft screws (thread M10 x 1). Due to the joint processing, the cover and the shaft are complete and marked with the same digits 1-1, 2-2, 3-3, 4-4, marked at the position shown by the arrows(7), and are folded so that the protrusions (1) on the shaft and (2) on the cover are on the same side. These protrusions are directed towards the front of the engine when mounting the piston rod to the engine.

Color of the group designation	Hole diameter, mm
Red	21,9970…21,9995
Yellow	21,9995…22,0020
Green	22,0020…22,0045
White	22,0045…22,0070

2.10. Table: SELECTION GROUPS FOR HOLES FOR THE PISTON ROD IN THE CRANKSHAFT SLEEVE

In the lobe cover (5), as in the crank handle head, thickeners are used to collect the material when balancing the crank handle. A two-stage channel (3) with diameters of 5 and 1.5 mm is drilled into the trapped part of the crankshaft head, at an angle of 45°, for splashing lubrication of the cylinder liner. The distance between the axis of the head and the crankshaft head axle is 202 ± 0,05 mm. Behind the distribution of the total mass (between head and left) the complete connecting rods are divided into four groups given in Table 2-11 and marked in the place shown by the arrow (8). The crankshafts of the same selection group are mounted on one motor.

Color of the group designation	Masa główki, g	Masa łba, g
White	260 ± 2	685 ± 2
Green	270 ± 2	685 ± 2
Black	270 ± 2	675 ± 2
Yellow	260 ± 2	675 ± 2

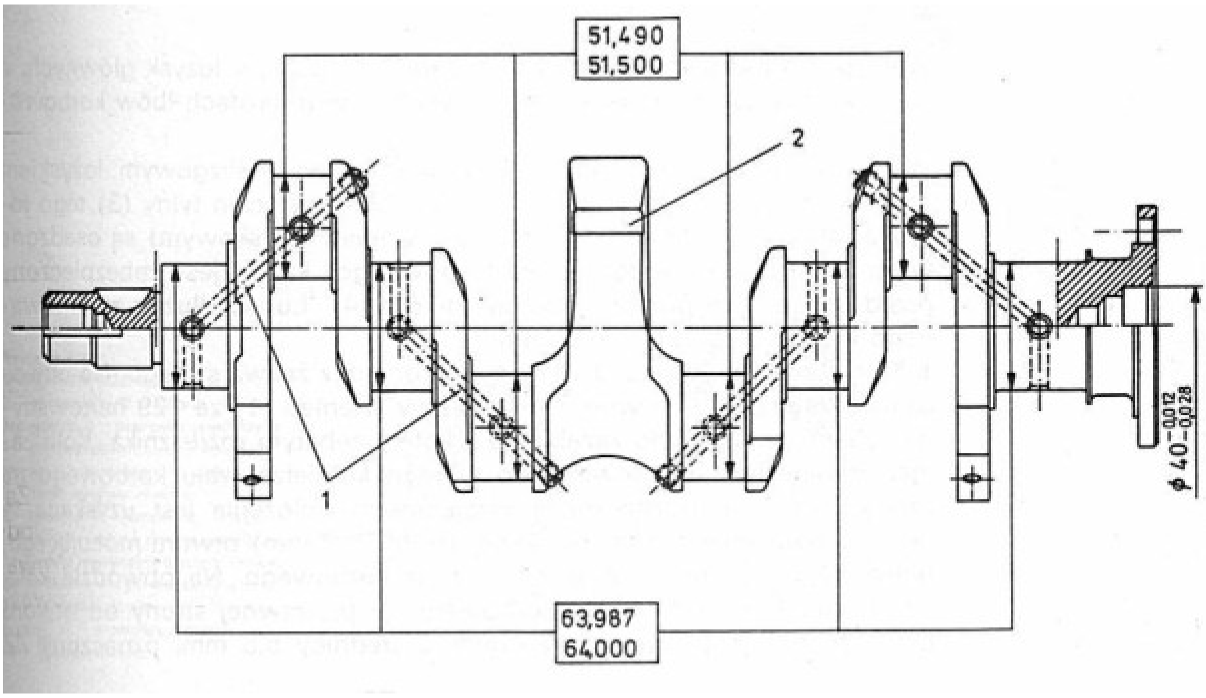
2.11. Table: SELECTION GROUPS FOR HOLES FOR THE PISTON ROD IN THE CRANKSHAFT SLEEVE

■ The crankshaft (Figure 2.12), forged from higher quality steel, has axles of main and crankpin pins in plane and connected by arms, the first, fourth and seventh of which are counterweighed to an accuracy of 0,002 N·m. The unbalance greater than that specified is eliminated by drilling holes (11 mm in diameter) in the counterweights of the first and seventh arms and in the counterweights of the fourth arm (26 mm in diameter). The four smoothed main pivots have a diameter of 63,987...64,000 mm and the four smoothed crankpins have a diameter of 51,490...51,500 mm. The main and crankshafts are surface hardened to a depth of 3...6 mm.

2.1.3 S-21 Crankshaft piston mechanism

To ensure proper lubrication of the main and crankshaft bearings, the pivots are provided with drilled holes (diameter 6.5 mm) connected by angled channels (1) and plugged plugs with tapered threads on the outer surfaces of the arms.

At the front end of the shaft are made pivots to fix (on the grooves): gear drive camshaft mechanism and belt pulley fan drive, cooling system pumps and generator. The first pin has a threaded hole for screwing in the crank gear.



1 - oil channels,
2 - shaft marker area

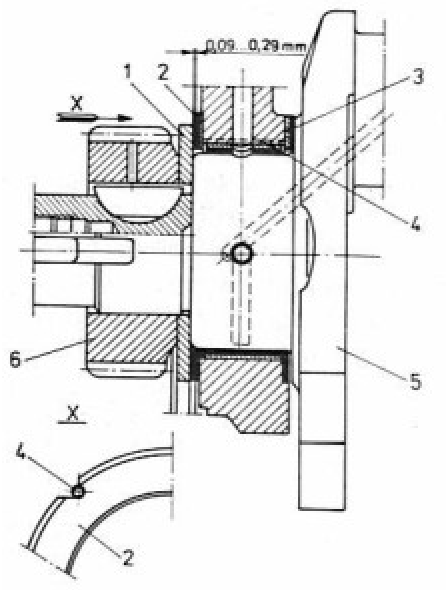
1 - kanały olejowe,
2 - miejsce cechowania walu

2.12. Figure: CRANKSHAFT (WAŁ KORBOWY)

At the rear end of the shaft there is an oil ejector, a four-hole flange with a diameter of $12^{+0,027}$ mm for attaching the flywheel and a gearbox clutch shaft bearing seat. The crankshaft, when assembled with the flywheel and clutch, is dynamically balanced to an accuracy of 0,007 N·m. Larger unbalances than those specified are eliminated by drilling holes with a diameter of 10 mm in the flywheel (on a diameter of 136 mm).

After balancing the complete set, the flywheel and the clutch guard are marked with the "0" symbol near one of the fastening screws. The shaft's production number and date of manufacture are stamped on the central counterweight at the point (2) shown in Figure 2.12. The letter markings are also stamped on the same point: G' for the fabrication of $63{,}75_{-0{,}013}$ mm diameter stubs or 'K' for the fabrication of $51{,}25_{-0{,}010}$ mm diameter stub crankshafts.

■ The main and crankshaft bearing shells are made as replaceable steel inserts, poured with a low-tin bearing alloy. The wall thickness of the main pan shall be $2{,}25_{-0{,}01}$ mm (with a steel strip thickness of $1{,}90_{-0{,}13}$ mm) and that of the crankpin shall be $1{,}74_{-0{,}01}$ mm (with a steel strip thickness of $1{,}40_{-0{,}2}$ mm). The accuracy of the bearings is ensured by the possibility of their installation without additional adjustment with pivots.

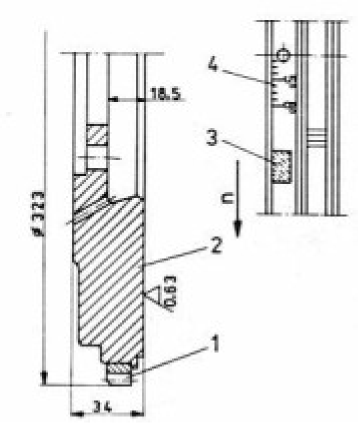


2.13. Figure: CRANKSHAFT THRUST BEARING (ŁOZYSKO OPOROWE WAŁU KORBOWEGO)

1 - the thrust ring,
2 - the front thrust ring of the thrust bearing,
3 - rear thrust bearing ring,
4 - safety peg,
5 - crankshaft,
6 - camshaft drive wheel

1 - pierścień oporowy,
2 - przedni pierścień lożyska oporowego.
3 - tylny pierścień łożyska oporowego.
4 - kolek zabezpieczający,
5 - wał korbowy.
6 - kolo napędzające wal rozrządu

The main pan shall have openings and circumferential oil grooves and the crankcase pan shall have openings for the distribution of engine oil only. The pans are protected against axial displacement and against rotation of the preload and edge protrusions.The protrusions are seated in hull sockets and main bearing covers, and in the case of crank bearing shells, in crankcase head sockets. The crankshaft is fixed in the axial direction of the thrust bearing (Fig. 2.13). The front ring (2) and the rear ring (3) of this box (steel spilled with a low-tin bearing alloy) are seated in the sockets of the first main bearing; each is secured against rotation by two pins (4). The longitudinal clearance of the assembled shaft is 0,09...0,29 mm.



1 - toothed ring,
2 - flywheel,
3 - warning rectangle,
4 - graduation for setting the ignition advance angle

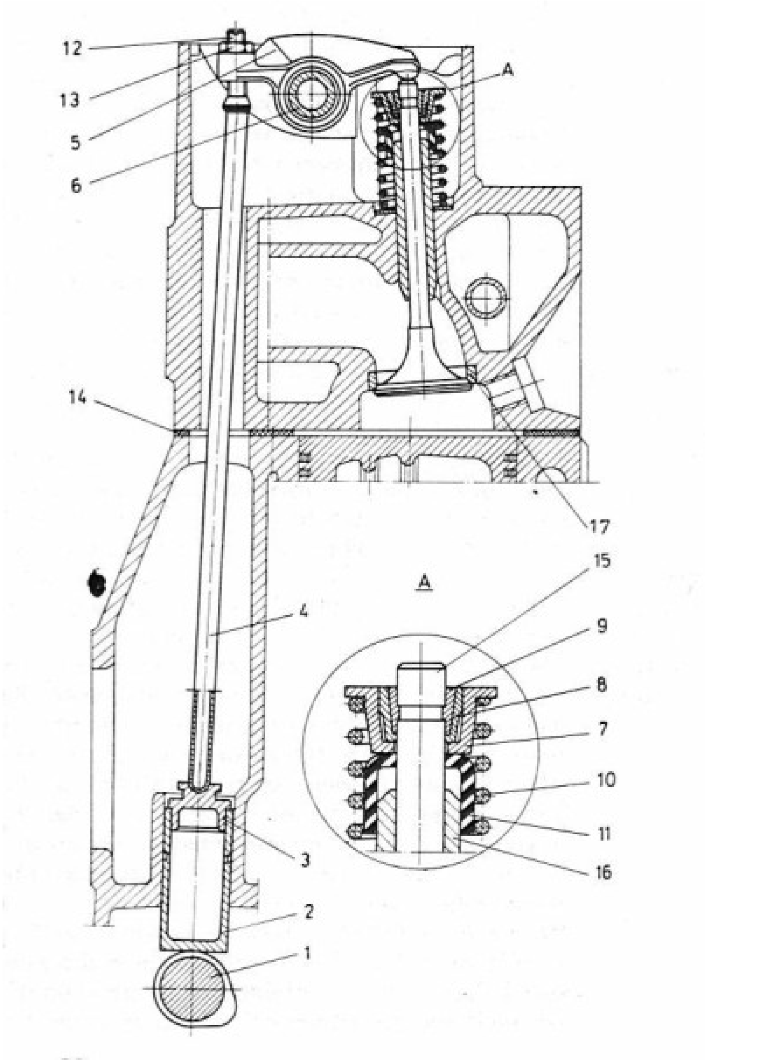
1 - wieniec zębaty,
2 - kolo zamachowe.
3 - prostokąt ostrzegawczy.
4 - podziałka do ustawienia kąta wyprzedzenia zapłonu

2.14. Figure: FLYWHEEL (KOŁO ZAMACHOWE)

■ The flywheel (Fig. 2.14) is made of grey cast iron. A steel wreath (1) with 129 hardened teeth is pressed onto the outer perimeter of the motor, so that it can be interlocked with the starter gear. The flywheel is attached to the rear flange of the crankshaft with four screws. The ambiguity of the mutual position is obtained by moving a clamping hole ($3{,}5^{+0{,}025}$ mm) located on the 2nd and 3rd sides of the crankpin from the vertical axis. On the circumference of the wheel, on the 1st and 4th sides of the crankpin (opposite the setting bore), a 5,5 mm diameter hole is drilled, marked ZZ (piston external turn). From this hole a scale (4) is cut to the right for setting the ignition advance angle. It shall be preceded by a white warning rectangle (3). The flywheel is statically balanced to an accuracy of 0,003 N·m by drilling (within a radius of 128 mm), on the side of the clutch disc, through holes with a diameter of 12 mm. The outer plane of the flywheel is used to mount the coupling casing (with six M8 x 1 screws) and is the thrust plane of the coupling disc.

2.1.4 S-21 Timing mechanism

The timing mechanism (Fig. 2.15) consists of the camshaft (located in the engine body), tappets, pusher rods, axle mounted valve levers, suction and exhaust valves (hanging) and valve springs. The system with the valves located in the head is called the upper valve timing. The timing mechanism is driven by two gears from the crankshaft. The drive ratio is 1:2 and results from the principle of four-stroke engine operation, in which the two crankshaft revolutions are the result of the working stroke in each cylinder. The crankshaft gear (made of higher quality structural steel) has 28 angled tines with left-hand direction of the screw line.



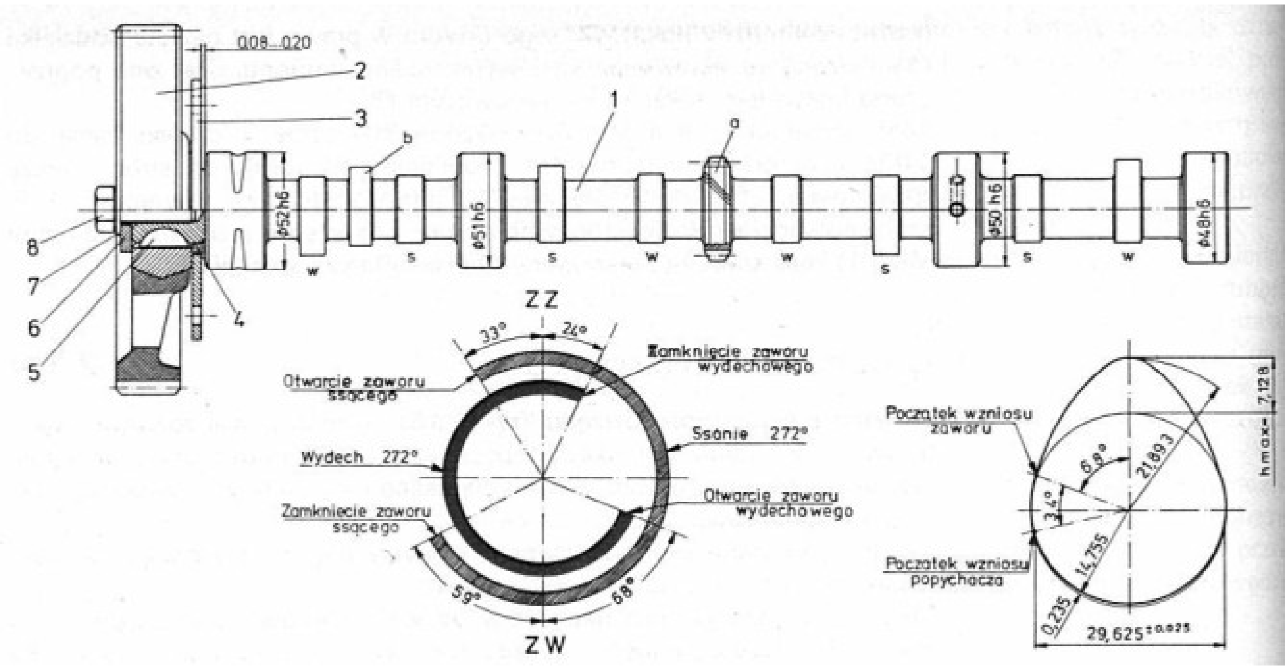
2.15. Figure: TIMING MECHANISM (MECHANIZM ROZRZĄDU)

1 - camshaft,
2 - camshaft body,
3 - camshaft cover,
4 - camshaft ladder,
5 - valve lever,
6 - valve lever axis,
7 - valve spring bowl.
8- insert,
9 - lock,
10 - valve spring,
11 - suction valve cover.
12 - valve lever adjusting screw,
13 - adjusting screw nut.
14 - Head gasket.
15 - valve stem.
16 - valve guide,
17 - valve seat

1 - wal rozrządu,
2 - korpus popychacza,
3 - pokrywka popychacza,
4- draźek popychacza,
5 - dźwignia zaworu,
6 - oś dźwigni zaworów,
7 - miska sprężyny zaworu.
8- wkladka,
9 - zamek,
10 - sprężyna zaworu,
11 - oslona zaworu ssącego.
12 - wkręt regulacyjny dźwigni zaworu,
13- nakrętka wkrętu regulacyjnego.
14 - Uszczelka głowicy.
15 - trzonek zaworu.
16 - prowadnica zaworu,
17- gniazdo zaworu

The cast iron camshaft gear has 56 angled tines with right-directional screw lines. In order to enable unambiguous and repeatable camshaft alignment, a tooth shifted 36°42' from the centreline of the groove of the shuttle groove shall be marked with a '0' mark on the crankshaft wheel face and an inter-cuttern rebate shifted 17°07' from the centreline of the groove of the groove to the centreline of the camshaft shall be fitted to the front of the larger wheel (on the crankshaft). During installation, the signs are aligned in a plane that passes through the crankshaft and camshaft axles. The angular gearing, the different materials used for the wheels and their selection in pairs ensure quiet operation of the camshaft drive.

2.1.4 S-21 Timing mechanism



2.16. Figure: CAMSHAFT WITH DRIVE WHEEL

1 - camshaft, 2 - toothed wheel. 3 - retaining plate, 4 - spacing ring, 5 - shuttle key, 6 - special washer, 7 - serrated washer, 8 - screw,
a - sprocket wheel for oil pump and ignition distributor drive,
b - eccentric drive of the fuel pump,
s - the cam on the suction tap,
w - cam of exhaust valve

1 - wał rozrządu, 2 - kolo zębate. 3 - płytka oporowa, 4 - pierścień odległościowy, 5 - wpust czółenkowy 6 - podkładka specjalna, 7 – podkładka ząbkowana, 8 - śruba,
a - kolo zębate napędu pompy oleju i rozdzielacza zapłonu,
b - mimośród napędu pompy paliwa,
s - krzywka zaworu ssącego,
w - krzywka zaworu wydechowego

■ The camshaft (Fig. 2.16), forged from higher quality structural steel, is mounted in the engine hull on four pivots, one $52_{-0,02}$ mm, the other $51_{-0,02}$ mm, the third $50_{-0,02}$ mm and the fourth $48_{-0,02}$ mm. Graduation of the journal diameter enables the roller to be mounted by sliding the motor body into the Sunday bearings (section 2.1.1). An oil channel is provided in the third journal to supply oil for the valve lever lubrication.

The inlet and outlet cams shall be arranged between the pivots and shall be as shown in Figure 2.16. The angular spacing of the elbows, measured from the groove (opposite the direction of rotation of the shaft), for the 1st cylinder shall be: the cam of the exhaust valve 8°25', the cam of the suction valve 115°55', and for the remaining positions every 90° from the above positions in the order of operation of the cylinders 2 to 4-3. The cam axes shall not coincide with those of the tappets. The adjustment is 1,5 mm, allowing the tappets to rotate during operation and the contact surface to wear evenly.

The diagram of the camshaft phasing unit is shown in Figure 2.16 (the graph is drawn up with an actual valve play of 0,295 mm for the suction valve and the exhaust as a function of the crankshaft rotation angle). The opening times of the suction and exhaust valves are the same, at 272°.

Color of the group designation	Pusher diameter, mm
Blue	24,978...24,989
Yellow	24,989...25,000

White	25,000...25,011

2.12. Table: SELECTION GROUPS OF TAPPETS

There is an eccentric drive between the cams on the first cylinder's inlet and exhaust valves for the fuel pump with an outside diameter of $36_{-0,16}$ mm. The eccentric cam axis coincides with the cam axis of the suction valve. Between the cams of the exhaust valves of the second and third cylinders, the gear wheel of the oil pump and the ignition distributor is cut on the camshaft. This wheel has 10 oblique tines with left inclination of the screw line and a fixed position in relation to the axis of the exhaust cam of the third cylinder. The cams, eccentric cams for the fuel pump drive and the gear wheel for the oil pump drive are surface hardened to a depth of 3...6 mm. The camshaft is axially fixed with a thrust plate (3, Fig. 2.16), made of high-manganese steel and bolted to the engine hull with two M8 screws; the axial clearance of the camshaft varies between 0,08...0,20 mm and is adjustable by a distance ring (4, Fig. 2.16)

■ The complete tappet (Fig. 2.15) consists of a body (2) and a cover (3) pressed from above. The tappet body, made of gray cast iron, has a flat foot (slip) hardened to a depth of 1,5...5,5 mm, which is used in conjunction with the camshaft cam. The cover, made of higher quality structural steel, is cyanated and hardened to a minimum depth of 0.18 mm. The tappets, like the guides in the hull (see Table 2-4), are selected into three dimension groups and marked in colors according to Table 2-12. During installation, the tappets and guides from the same selection group are assembled.

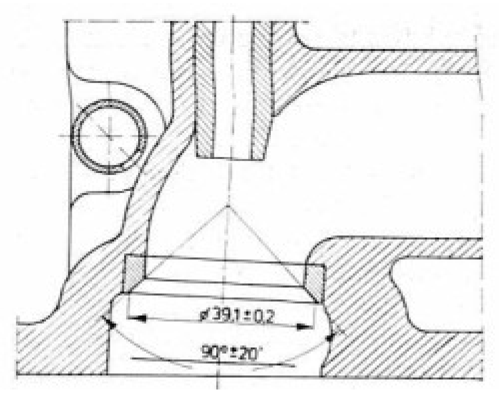
■ The tappet rods (4, Fig. 2.15) are made of seamless, thin-walled tubular steel. The ends are joined by welding with steel balls with a diameter of 8 mm. Rods with rolled and hardened pipe ends are also used. The total length of the rod shall be 270,5 ± 0,65 mm.

■ Valve levers (5, Fig. 2.15), forged from higher quality structural steel, mediate the movement of the tappet rod onto the valve. The lever arm on the valve side is ended with a cylindrical tip, hardened to a depth of 2...4 mm, with a radius of 10 mm. The opposite arm is ended with a hub with a M8 x 1 threaded hole for screwing in the adjusting screw (12, fig. 2.15), fixed with a hand on the counter nut (13, fig. 2.15), after adjusting the valve backlash.

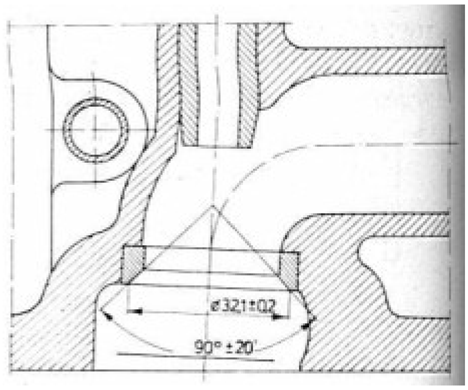
The lever is supported by a brown sleeve pressed into the hub (with the contact line horizontally towards the adjusting screw) with an internal diameter of $21^{+0,028}_{-0,007}$ mm. The oil channel with a diameter of 3 mm is drilled into the lever hub at an angle of 30° upwards (towards the adjusting screw).

■ The adjusting screws of the valve lever (12, Fig. 2.15) are made of higher quality structural steel. On one side they have an overlap of 1.2 mm per screwdriver, on the other side they have a spherical bowl, hardened to a depth of 3.5 mm; in the bowl there is a 2 mm diameter oil channel drilled to lubricate the ends of the rods will push out the oil coming out of the hole in the valve lever.

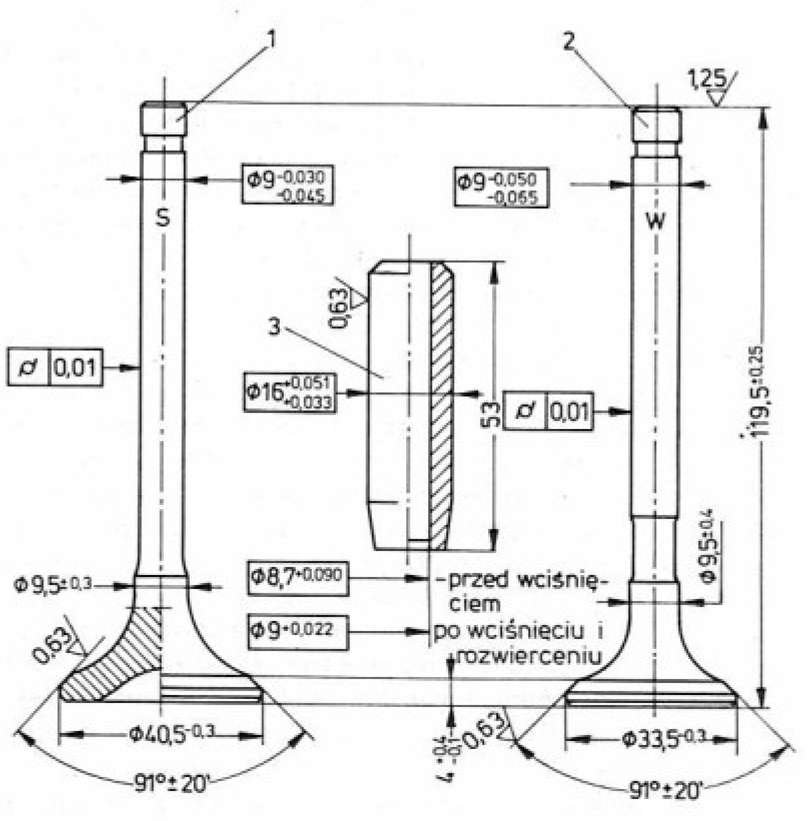
■ The valve levers (8 pcs.) are mounted on two hollow axles (6, fig. 2.15) with a diameter of $21_{-0,013}$ mm, made of higher quality structural steel and surface hardened to a depth of 1...2 mm.



2.17. Figure: CROSS-SECTION OF THE SUCTION VALVE SEAT



2.18. Figure: CROSS-SECTION OF THE EXHAUST VALVE SEAT



1 - suction tap.
2 - exhaust valve.
3 - valve guide

1 - zawór ssący.
2 - zawór wydechowy.
3 - prowadnica zaworu

2.19. Figure: VALVES WITH VALVE GUIDES

The axles are connected by a steel rubber bushing and fixed with two special M8 bolts in the head brackets; the inner holes of the axles fulfill the task of the oil channel and are closed on both sides with metal plugs. Oil is supplied to the individual valve levers through $3^{+0,25}$ mm diameter through holes drilled at the lever positions on the axles.

Valve levers, arranged along the axis, are separated by springs made of 1,8 mm diameter wire to provide flexible spacing elements.

■ The inlet and outlet valve seats of alloy cast iron and the valve guides (see 3, Fig. 2.19) are shrunk in the head (Chap. 2.1.2) when heated to 200°C. The dimensions of the suction valve seat

flap are shown in Figure 2.17 and of the exhaust valve seat in Figure 2.18. The inside diameter of the valve guide in which the valve stem operates is $9^{+0,022}$ mm.

■ The suction valves made of higher quality structural steel and the exhaust valves made of heat-resistant steel have different dimensions and shape of buttons (Fig. 2.19). The handle ends are hardened to a depth of 3...5 mm. The valves are marked as follows on the handle (under the lock): in suction, by the letter 'S', in exhaust, by the letter 'W'. The total length of both valves is the same and amounts to 119,5 ± 0,25 mm. The handle diameter is $9^{-0,030}_{-0,045}$ mm for the suction valve and $9^{-0,050}_{-0,065}$ mm for the exhaust valve.

■ Exhaust valves are installed in guideways with high backlash due to their high operating temperature. The caps of the suction valves are fitted with oil-resistant rubber covers (11, Fig. 2.15) to prevent oil from entering the combustion chamber during the suction stroke along the handle.

■ Valve locks (detail A, figure 2.15) consist of two half cones (9), clamped in an insert (8), resting against the valve spring bowl (7) on top of the face of the ring. This design allows the valves to rotate around the axis during opening and closing, thus increasing the durability of the valve side.

■ Valve springs (10, Fig. 2.15) are made of 4.1 mm diameter hardened wire. The number of coils is 8,25 ± 0,3, the winding direction is left. In order to increase the natural frequency and to effectively dampen free elastic deformation, the spring is wound with variable pitch; the side with thickened coils is mounted in the direction of the seat in the head. The characteristics of the springs are given in Table 2-13 and the springs are shot peened for high fatigue strength.

Spring length, mm	**Force, N**
44,5 35,7	171,5...225,4 441…509,6

2.13. Table: VALVE SPRING CHARACTERISTICS

2.1.5 S-21 Air/Fuel Supply

The S-21 engine power supply system shall consist of a fuel pump, a fuel tank, 28/35 S2A1 or 28/35 S2B1 carburetors, a dry air filter with an interchangeable filter insert and an engine suction line. The purpose of the system is to supply fuel and air to the combustion chambers of the engine in a proportion forming a flammable mixture.

■ The fuel pump, of diaphragm type (Fig. 2.20), pumps the fuel from a tank located under the car frame into a carburetor installed on the engine; it is driven by a lever (19) from the camshaft eccentric. The pump consists of a casing, base and fuel settling tank. A diaphragm (5) is fitted between the pump casing and the pump casing, made of fabric coated with gasoline resistant rubber. A string (3) is screwed to the diaphragm in its central part by two metal cups and connected to the lower end of the string by a sliding link to the arm (2) of the drive lever (19). The lever is swiveled into the pump base. The diaphragm rod is sealed with a rubber seal in the base seat. Two identical plate valves (Fig. 2.21), a mesh filter (11) and a fuel settling tank closed with a glass (10) and pressed against the body by a wing nut of the outer yoke (12) are fixed in the body by means of a yoke (15). The pump is attached to the motor casing with M8 screws by means of an 8 mm thick insulation washer (21) and two gaskets (20). This method of attachment protects the pump casing

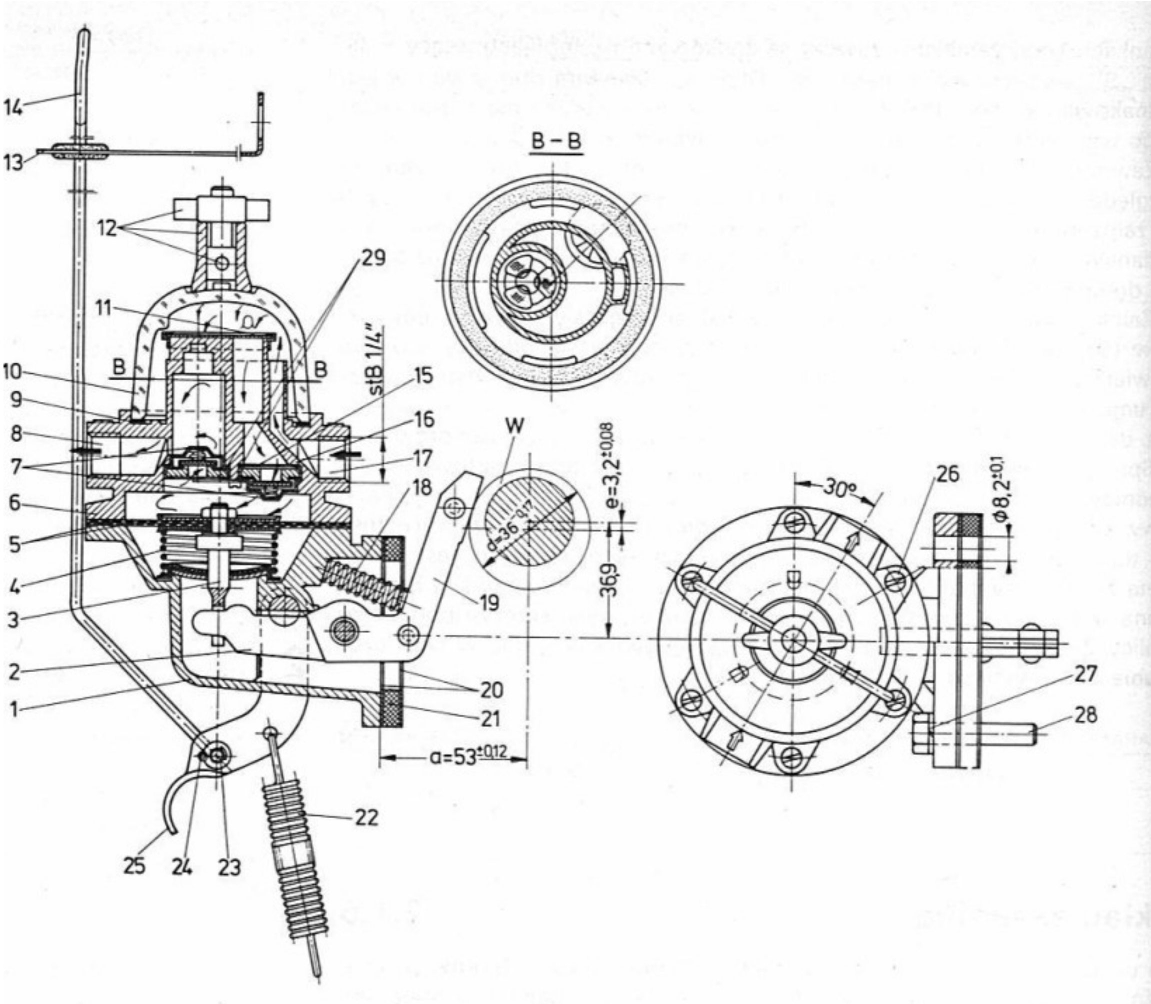
against excessive heating and the formation of steam plugs in the fuel system. Fuel is drawn in through the inlet (17), the settling tank, the mesh filter and the suction valve into the space above the diaphragm as it moves downwards. This movement is enforced by the drive lever (19), which works together with the camshaft eccentric camshaft and is pressed against it by the spring (18). The diaphragm spring (4) is compressed during the suction stroke and the outlet valve (7) is closed. When the eccentric cam is rotated beyond the maximum lift, the lever (18) falls down and releases the arm (2) under the influence of the spring. The diaphragm, under the action of the spring (4), moves upwards, pumping fuel through the outlet valve (7) and the channel (8) (which opens as a result of overpressure) to the carburetor. After filling the float chamber with fuel, the float closes its further supply by means of a needle valve. For this reason, an overpressure in the line connecting the pump to the carburetor is created, balanced by the spring force (4), which automatically reduces the diaphragm stroke (5). Thus, despite the constant stroke, the lever (19) moves the arm (2) and diaphragm cable (3) only to a limited extent.

At the extreme, if the excess pressure in the line is increased so that the spring (4), with the characteristics given in Table 2-14, is compressed as much as possible, the lever (19) will stop pulling the arm (2) and the pump will feed fuel when it is in normal motion. Since the fuel is pumped under the influence of the spring (4), the discharge pressure depends exclusively on the characteristics of the spring. The maximum discharge pressure is between 20 and 26.7 kPa, the minimum suction pressure is 46.7 kPa and the minimum volumetric flow rate at an angular camshaft speed of 1800 rpm is 50 dm^3/h.

Total number of reels	5,5
Number of working coils	3,5
Wire diameter	2,0 mm
Wrapping diameter	31,0 mm
Height in free height	50 mm
Height under load 47,6 ± 3,5 N	35 mm

2.14. Table: SPRING CHARACTERISTICS OF THE FUEL PUMP DIAPHRAGM

The pump is also equipped with a manual fuel pumping lever (25) which is used for quick fuel filling in the fluid-water chamber of the carburetor (with the engine not running).

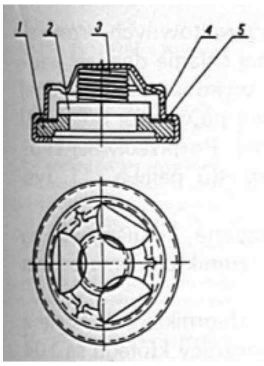


2.20. Figure: FUEL PUMP (POMPA PALIWA)

1 - pump casing. 2 - drive lever arm. 3- diaphragm cable, 4 - diaphragm spring, 5 - Diaphragm, 6 - cover, 7 - plate valves, 8 - outlet duct. 9 - gasket, 10 - a glass of fuel tank. 11 - mesh filter, 12 - yoke of the glass of the fuel tank, 13 - tendon support, 14 - rod, 15 - valve yoke. 16.26 - screws, 17 - inlet duct. 18 - spring of the driving lever. 19 - drive lever, 20 - gaskets, 21 - insulation pad, 22 - return spring, 23, 27 - washers, 24 - pin, 25 - hand pumping lever, 28 - screw, 29 - plate valve seats

1 - korpus pompy. 2 - ramię dźwigni napędzającej. 3- cięgno przepony, 4 - sprężyna przepony, 5 - przepona, 6 - pokrywa, 7 - zawory płytkowe, 8 - kanał wylotowy. 9 - uszczelka, 10 - szklanka osadnika paliwa. 11 - filtr siatkowy, 12 - jarzmo szklanki osadnika paliwa, 13 - wspornik cięgna, 14 - ciegno, 15 - jarzmo zaworów. 16.26 - wkręty, 17 - kanał wlotowy. 18 - sprężyna dźwigni napędzającej. 19 - dźwignia napędzająca, 20 - uszczelki, 21 - podkladka izolacyjna, 22 - sprężyna powrotna, 23, 27 - podkładki, 24 - zawleczka, 25 - dźwignia ręcznego pompowania, 28 - śruba, 29 - gniazda zaworów płytkowych

The fuel is pumped by pulling the rod (14) upwards. The return spring (22) returns the lever. The principle of operation is the same as that of a mechanical drive, since the lever (25) is kinematically connected to the arm (2). To ensure normal operation of the pump, the lever (25) should always be in the lower position as it does not restrict the stroke of the arm (2).



2.21. Figure: FUEL PUMP PLATE VALVE

1 - seat, 2 - plate, 3 - spring, 4 - housing, 5 - gasket

1 - gniazdo, 2 - plytka, 3 - sprężyna, 4 - obudowa, 5 - uszczelka

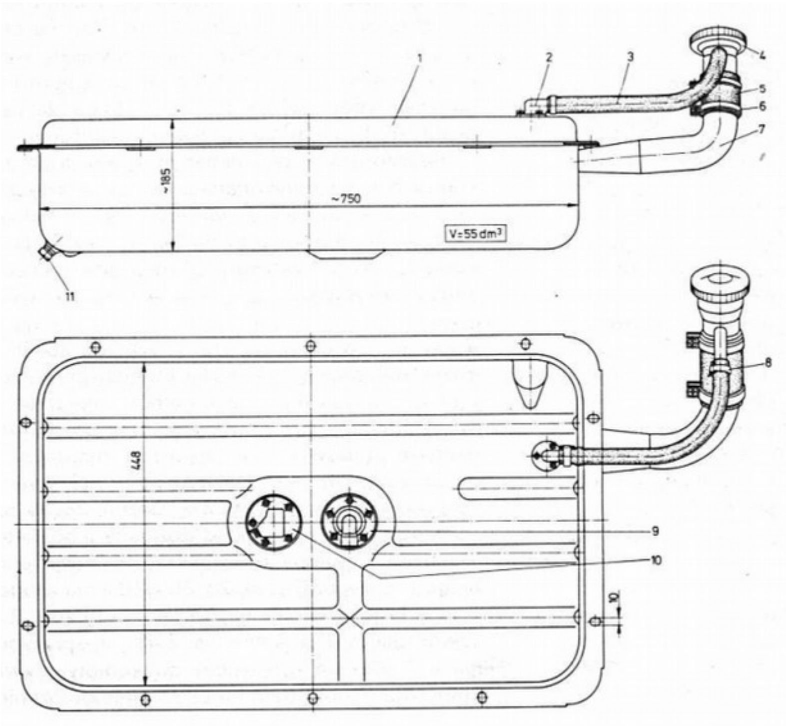
■ The 55 dm^3 fuel tank (Fig. 2.22) consists of two leaded steel sheet extrusions, which are welded linearly along the flanges, which are also the rim to which the tank is attached by ten M8 bolts to the car frame. The tank is located on the right side of the vehicle, between the second and third bars of the frame. The tightness of the container shall be checked by an air pressure of 39 kPa. At the bottom of the tank (bottom), two transverse baffles with three 25 mm diameter holes are attached to the side walls by welding, between them a longitudinal baffle with two holes of the same diameter; their function is to suppress sudden movements: the puppy of fuel masses while the vehicle is moving. A 50,0 ± 0,3 mm diameter filling tube made of bleached steel strip is laid in the rear wall of the bottom, supported by the other end (flattened at 30 × 63,0 mm) in the rear cross-partition. On the opposite side, in the lower corner, there is a fuel drain plug (11, fig. 2.22).

In the upper part of the tank (lid) the fuel dragon (9) and the fuel level sensor are flanged with M5 screws (through gaskets) (10).

The dragon of fuel reaches the lowest point in the tank bottom. It consists of a body (a steel strip rolled up in a cylinder, on the side of which there are 104 holes with a diameter of 5,3 mm) covered with a brass filter net (1000 holes per 1 cm) and two covers: one at the bottom and one at the top. A steel suction tube (8 x 1.2 mm) is fed centrally through the top cover and soldered around the entire circumference to the bottom cover. The tube has two 3 mm diameter holes at the end, adjacent to the lower cover, through which the filtered fuel is sucked into the supply system. The design and operation of the fuel level sensor is discussed in Chapter 7.

The tank is filled with fuel through a throat, made of lead steel, connected to the fuel filler pipe (7) by tight welding on the whole circumference (in cars A111, A161 and A17 and A171...A175) or with a flexible rubber hose (5), fixed on two clamping bands (in other car variants). A vent pipe (3) is soldered into the throat to remove air and fuel vapor from the tank while it is filling. The throat flange is turned inwards and its edge is shaped in the form of two sloping troughs, ended with bumpers.

2.1.5 S-21 Air/Fuel Supply



1 - cover, 2 - vent pipe end. 3 - vent pipe. 4 - fuel filler cap, 5 - throat pipe. 6, 8 - compression clamps, 7 - fuel filler pipe, 9 - fuel dragon, 10 - fuel level sensor, 11 - fuel drain plug

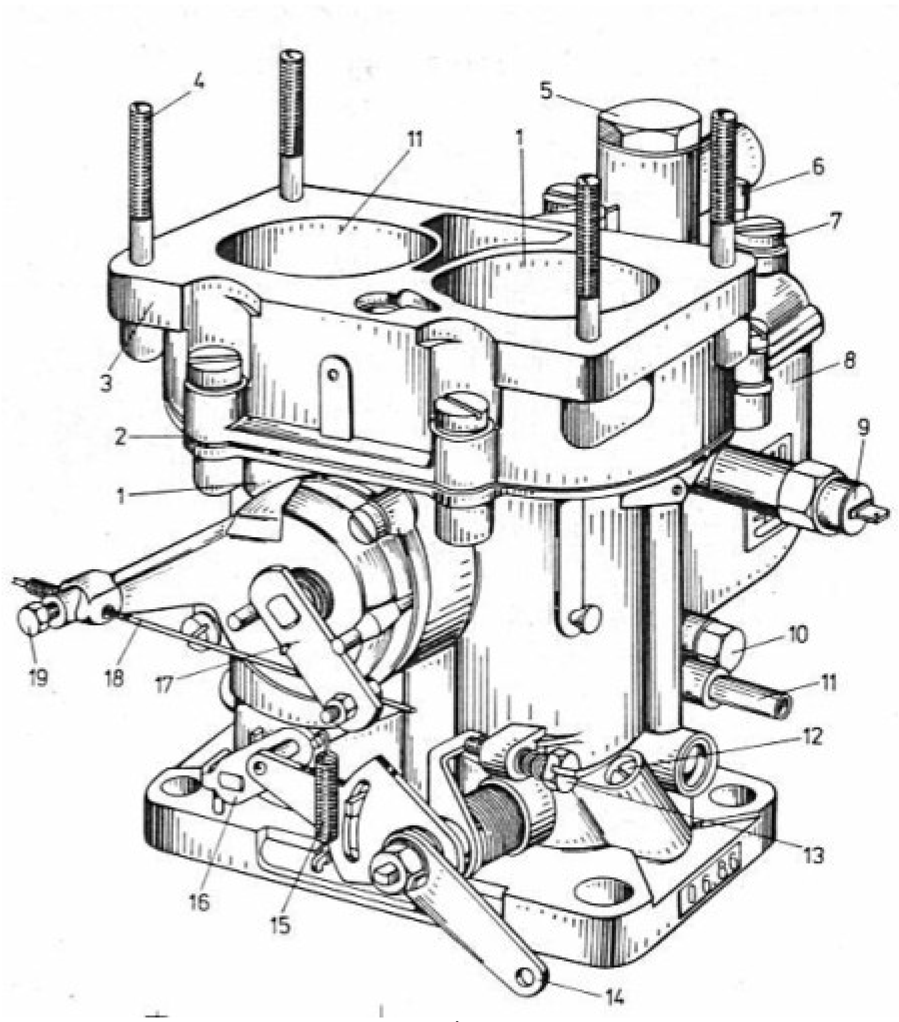
1 - pokrywa, 2 - końcówka rurki odpowietrzającej. 3 - rurka odpowietrzająca. 4- korek wlewu paliwa, 5 - przewód gardzieli. 6, 8 - opaski zaciskowe, 7 - rura wlewu paliwa, 9 - smok paliwa, 10 - czujnik poziomu paliwa, 11 - korek spustu paliwa

2.22. Figure: FUEL TANK (ZBIORNIK PALIWA)

The filler cap (4) consists of a captive body. In the upper wall of the cap there is a 1,5 mm diameter hole which saves the tank from the atmosphere and allows the pressure to be equalized as the fuel level in the tank decreases. The plug is fixed on the throat (through the gasket) by two catches and is secured against losing the chain connected to the spring ring, placed in the internal hole of the throat. There are also used plugs with a cover made of plastic, which by the principle of operation do not differ from the ones described above, and plugs with a lockable key, in which between the body and cover there is a ratchet lock drum built. The locking mechanism is rotated by the eccentric cam. The keyhole is weatherproof with a rotating lid.

■ The 28/35 S2A1 (Fig. 2.23) or 28/35 S2B1 carburetors are precipitation, two-throw carburetors, for which the control data are given in Table 2-18. The nominal diameters of the mixing chambers are 28 and 35 mm. It consists of two main parts: a casing and a cover made of zinc alloy castings. The casing is equipped with: nozzles, throttles, throttles and nozzles, and in the cover - with needle valve, fuel filter and float chamber float. The S2A1 28/35 carburetor has the following systems and devices: a main dosing system with air braking of the fuel flow, an acceleration pump, a starting device and an idling device. The 28/35 S2B1 carburetor has an additional saving feature. The fuel flows through the needle valve (2, see Fig. 2.49) with the firing pin spring vibration damper (ball on spring) into the float chamber, where the float (7), fixed rotationally on the axis, controls the position of the firing pin.

2.1.5 S-21 Air/Fuel Supply



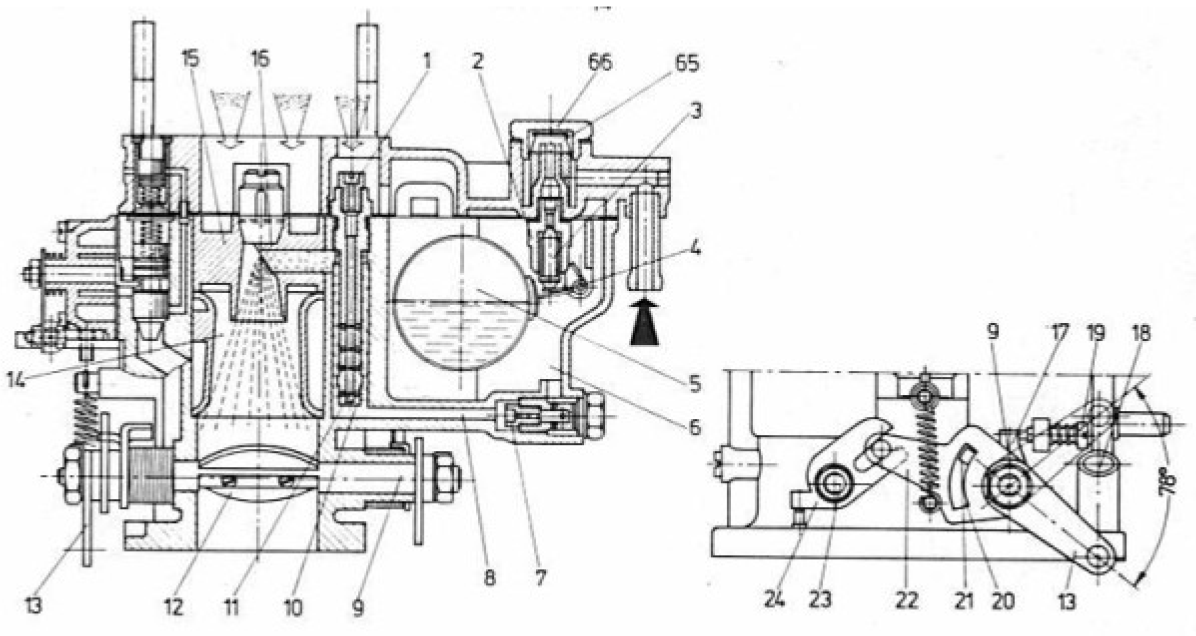
2.23. Figure: CARBURETOR (GAŻNIK) 28/35 S2A1

1 - carburetor housing, 2 - gasket, 3 - carburetor cover. 4 - stud bolts, 5 - fuel filter plugs, 6 - fuel inlet ports, 7 - float chamber covers. 8 - float chamber. 9 - solenoid valve at idle. 10 - main fuel nozzle. 11 - spigot of the vacuum line of the ignition distributor regulator, 12 - the screw of the idle speed control, 13 - the screw of the mixture and passage throttle control, 14 - the lever of the mixture and passage throttle control. 15 - spring. 16 - Release lever, 17 - Starting device lever, 18 - Cord, 19 - Cord arm fixing screw, 19 - Cord armour fixing screw, 16 - Cordless lever, 17 - Starting device lever, 18 - Cord, 19 - Cord armouring screw, 19 - Cord armouring screw.

1 - obudowa gaźnika, 2 - uszczelka, 3 - pokrywa gaźnika. 4 - śruba dwustronna, 5 - korek filtru paliwa, 6 - króciec dopływu paliwa, 7 - pokrywa komory plywakowej. 8 - komora pływakowa. 9 - zawór elektromagnetyczny biegu jałowego. 10 – główna dysza paliwa. 11 - króciec przewodu podciśnieniowego regulatora rozdzielacza zaplonu, 12 - wkret regulacji prędkości obrotowej biegu jałowego, 13 - wkręt regulacji położenia przepustnicy mieszanki i przelotu, 14 - dźwignia sterowania przepustnicą mieszanki I przelotu. 15 - sprężyna. 16 - dźwignia zwalniająca, 17 - dźwignia urządzenia rozruchowego 18 - cięgno, 19 - śruba ustalająca pancerz cięgna

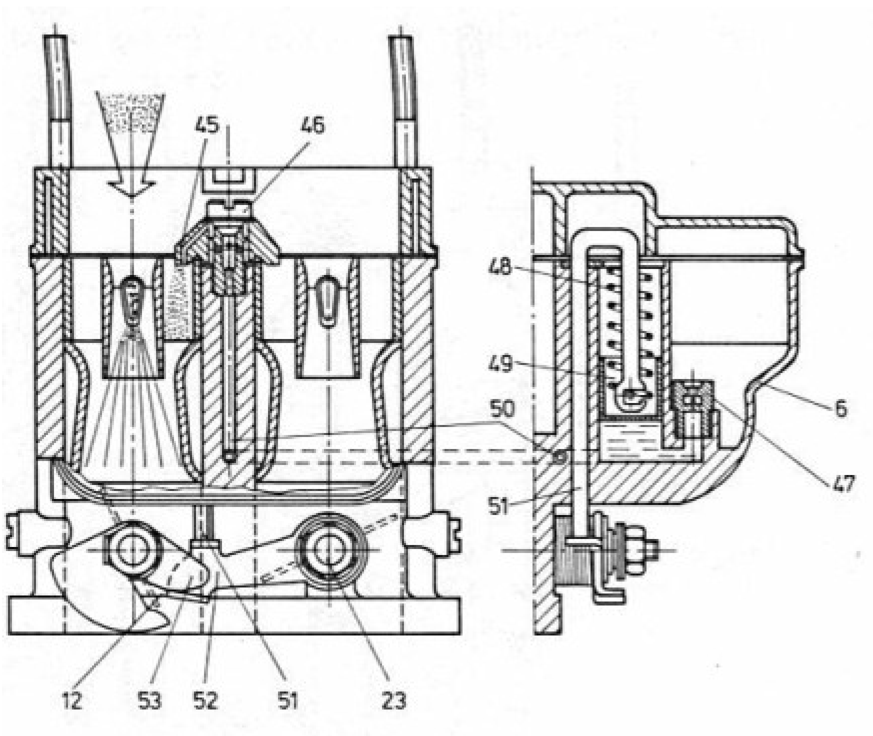
1 - air nozzle inhibiting fuel outflow, 2 - needle valve. 3 - needle with vibration damper, 4 - float axis, 5 - float, 6 - float chamber, 7 - main fuel nozzle. 8 - fuel channel, 9 - throttle axis. 10 - well of the main dosing device. 11 - emulsion tube, 12 - throttle and throttle, 13 - throttle lever ! overflight. 14 - throat of the first flight, 15 - throat of the first flight. 16 - Sprayer. 17 - limiting lever. 18 for the idle speed control screw, 19 for the throttle control screw. 20 - cut-out of the release lever. 21 - stop lever hook. 22 - lever 23 - throttle axis of 11th flight. 24 - throttle lever Flight rate, 65 - fuel filter, 66 - fuel filter plug

1 - dysza powietrza hamującego wypływ paliwa, 2 - zawór iglicowy. 3 - iglica z amortyzatorem drgań, 4 - oś pływaka, 5 - pływak, 6-komora pływakowa, 7 - główna dysza paliwa. 8 - kanał paliwa, 9 - oś przepustnicy. 10 - studzienka głównego urządzenia dozującego. 11 - rurka emulsyjna, 12 - przepustnica i przelotu, 13 - dźwignia napędowa przepustnicy ! przelotu. 14 - gardziel I przelotu, 15 - gardziel wstępna. 16 - rozpylacz. 17 - dźwignia ograniczająca. 18 - wkręt regulacji prędkości obrotowej biegu jałowego, 19 - wkręt regulacji położenia przepustnicy. 20 - wycięcie dźwigni zwalniającej. 21 - zaczep dźwigni ograniczającej. 22 - dźwignia ająca, 23 - oś przepustnicy 11 przelotu. 24 - dźwignia przepustnicy Il przelotu, 65 - filtr paliwa, 66 - korek filtru paliwa



2.24. Figure: CARBURETOR (GAŻNIK) 28/35 S2A1 - MAIN DOSING SYSTEM WITH AIR BRAKING OF FUEL OUTFLOW

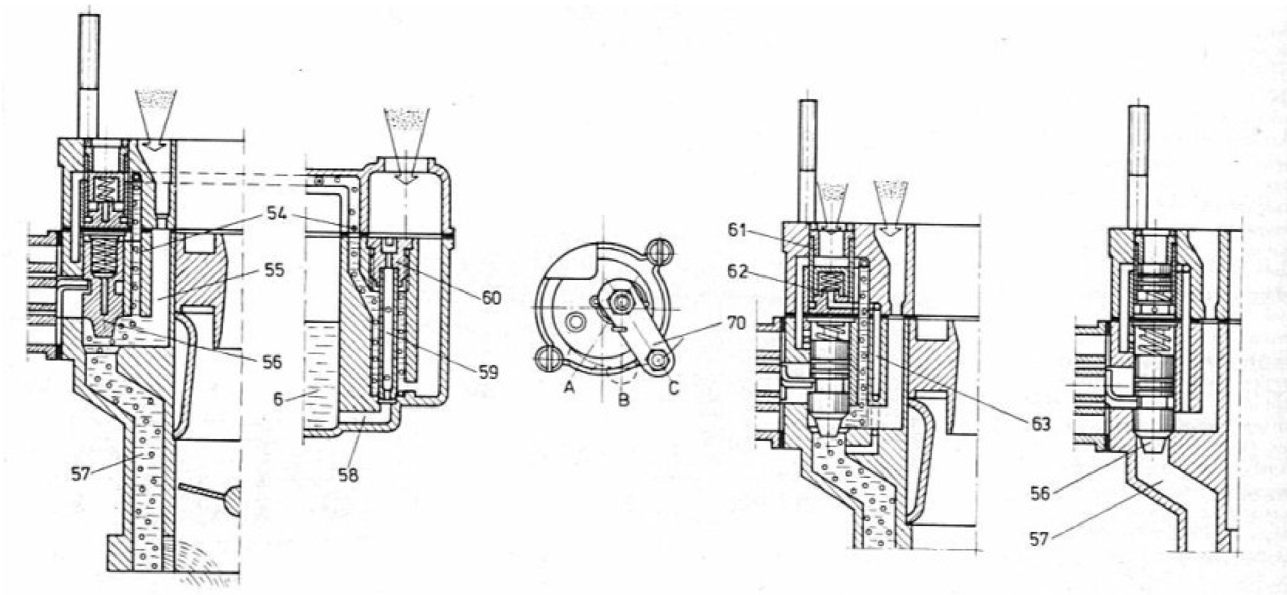
The main dosing system with air braking of the fuel outflow (Fig. 2.24) is supplied from the float chamber by the main fuel nozzle (7), channel (8) and well (10) with an emulsion tube (11) located in the middle. As the engine speed (or load) increases, the fuel supply from the float chamber is braked by the air, which flows counterflow through the nozzle (1) to the pipe (11), from where the emulsion mixture is entrained by the nozzle (16) to the primary throat (15) and then to the main throat (14). The driver controls the throttle and the flight. The opening of this damper, as a result of the mechanical interconnection, regulates the degree of opening of damper II of the flight. The lever (13) rotates the throttle axle (9) with the stop lever (17) attached, the hitching of which (21) moves freely at the beginning in the notch (20) of the release lever (22), and as it rotates further, the axis of the lever (13) starts to rotate the lever (22). This lever acts on the lever (24) fixed on the throttle axis II of the flight (23), which in turn opens the throttle and the throttle gradually until it is fully swivelled out. Full throttle and throttle lever rotation (13) 78°.



2.25. Figure: CARBURETOR (GAŻNIK) 28/35 S2A1 - ACCELERATOR PUMP

6 - float chamber,
12 - throttle I,
23 - throttle II,
45 - accelerator pump injector.
46 - discharge ball valve,
47 - suction ball valve,
48 - pump piston spring,
49 - pump piston,
50 - fuel channel,
51 - guide bar.
52 - control lever for the guide bar,
53 - control lever for overflight and steering

6 - komora pływakowa,
12 - przepustnica I przelotu,
23 - przepustnica II przelotu,
45 - wtryskiwacz pompy przyśpieszającej.
46 - zawór kulkowy tłoczenia,
47 - zawór kulkowy ssania,
48 - sprężyna tłoka pompy,
49 - tłok pompy,
50 - kanał paliwa,
51 - drążek prowadzący.
52 - dźwignia sterowania drążka prowadzącego,
53 - dźwignia sterująca I przelotu

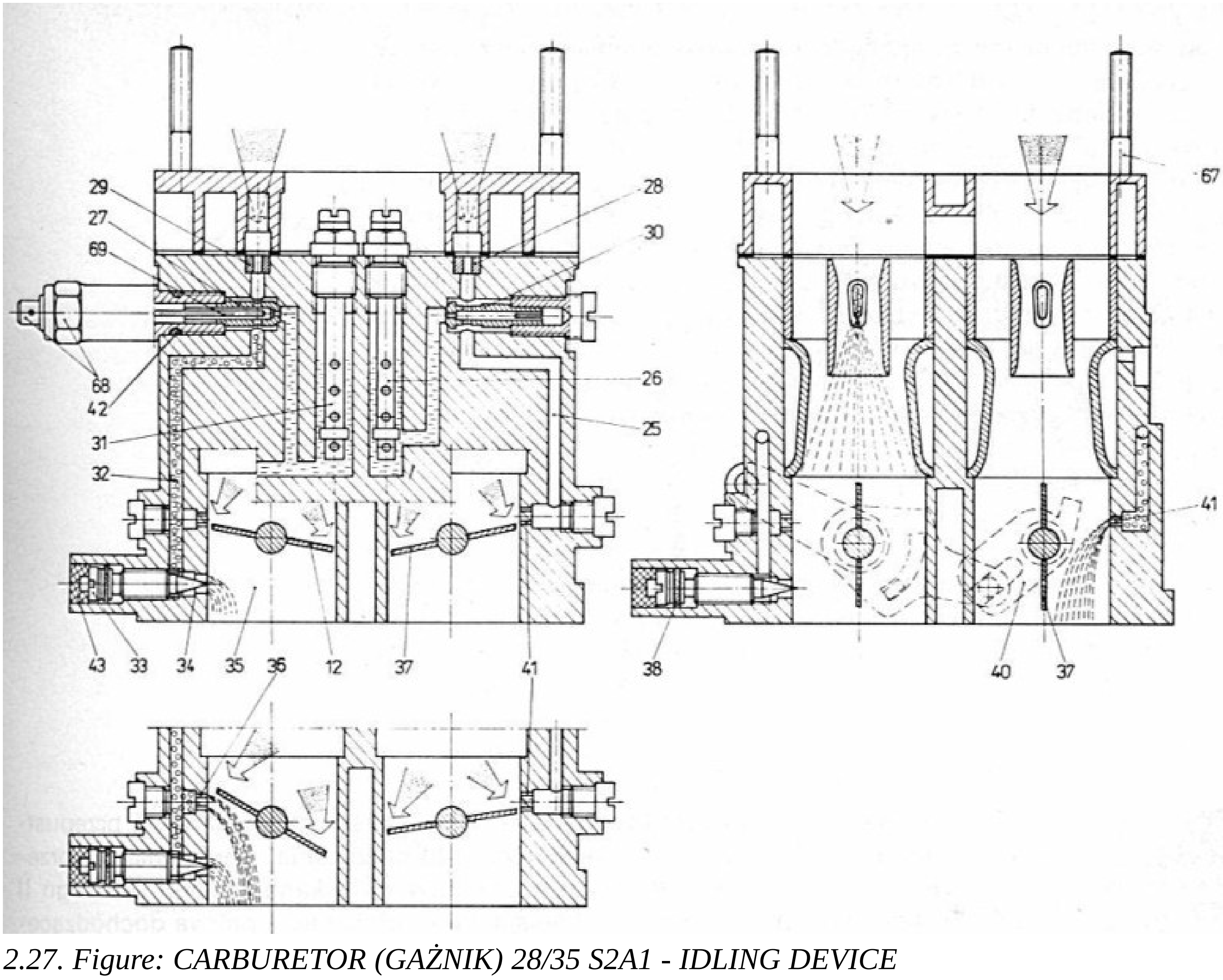


2.26. Figure: CARBURETOR (GAŻNIK) 28/35 S2A1 - STARTER

A - device fully switched on,
B - device partially bundled,
C- device switched off,
6 - float chamber, 54 - emulsion channel. 55 - air duct, 56 - air starter piston. 57 - mixture outlet channel, 58 - cross-flow fuel channel, 59 - starting nozzle, 60 - fuel inhibiting air nozzle, 61 - bowl, 62 - air valve, 63 - vacuum channel for air valve control, 70 - lever for starting device

A - urządzenie całkowicie włączone,
B - urządzenie częściowo wiączone,
C- urządzenie wyłączone,
6 - komora pływakowa, 54 - kanal emulsyjny. 55 - kanał powietrza, 56 - tloczek urządzenia rozruchowego. 57 - kanał wylotowy mieszanki, 58 - kanał poprzeczny dopływu paliwa, 59 - dysza rozruchowa, 60 - dysza powietrza hamującego wypływ paliwa, 61 - miseczka, 62 - zawór powietrza, 63 - kanał podciśnieniowy sterowania zaworem powietrza, 70 - dźwignia urządzenia rozruchowego

The starter/piston type acceleration pump (Fig. 2.25) is fed from the float chamber (6) by a non-return ball valve (47) during upward movement of the piston (49) each time the throttle and throttle (12) are closed. By releasing the catch of the intermediate lever (52), which is pivoted on the throttle axis of the 2nd loop (23), the spiral spring moves the lever upwards, transferring the movement via the guide bar (51) to the piston (49). The piston pushes the spring (48) upwards. The well under the piston is filled with fuel. When the throttle (12) is opened suddenly, the lever (52) is lowered with the aid of the lever (53). The stick (51) loses contact with the lever face (52). The spring (48) expands the fuel through the channel (50) through the valve (46) to the injector (45), through which it is injected into the throat and flight, temporarily enriching the mixture. The piston type starting device (Fig. 2.26) is controlled by a lever (70) with an operating angle of 68°. The lever has three positions: A - cold start (device fully switched on), B - warm start (device partially switched on), C - start (device switched off).



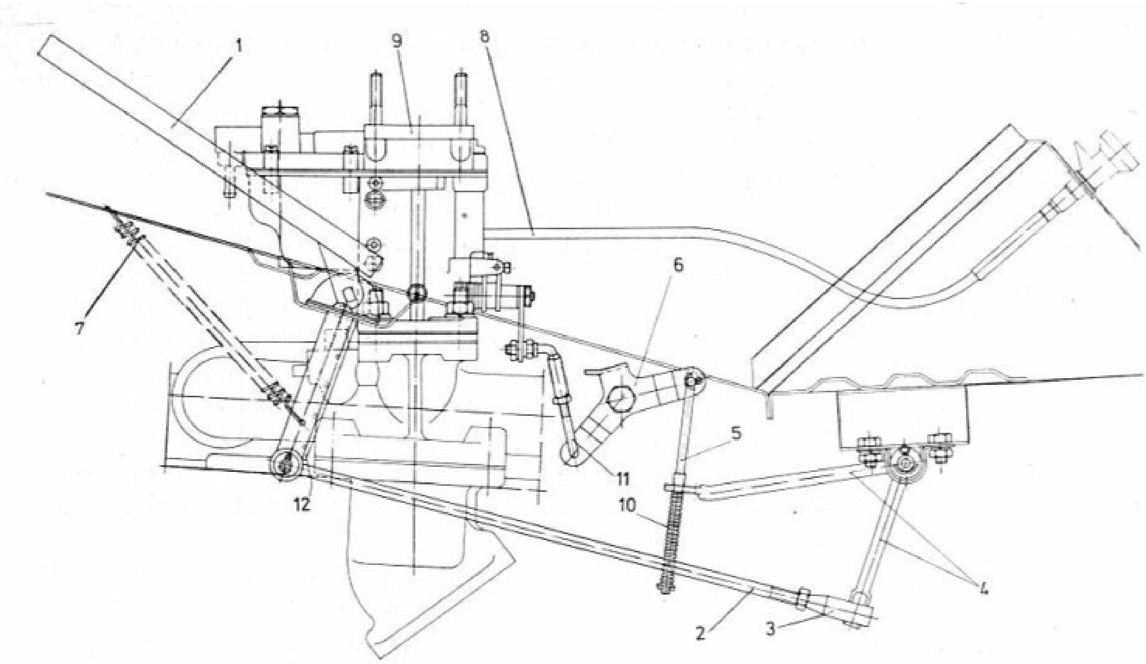
2.27. Figure: CARBURETOR (GAŻNIK) 28/35 S2A1 - IDLING DEVICE

12 - mixture and throttle throttle, 25 - emulsion channel of the 2nd flight. 26 - emulsion tube Passage number, 27 - idle fuel nozzle for 1st trip, 28 - air nozzle for 2nd trip. 29 - air nozzle and passage. 30 - idle fuel nozzle of trip II, 31 - emulsion pipe and trip, 32 - emulsion channel and trip. 33 - screw for idling speed control, 34 - outlet opening of the emulsion, 35 - mixing and passage chamber, 36 - progressive openings of the emulsion and passage, 37 - throttle The number of passages. 38 - sealing ring. 40 - throttle lever of mixture of 11 flights. 41 - transition holes II of the passage, 43 - blind cover, 67 - stud for air filter mounting. 68 - solenoid jumper. 69 - valve spire

12 - przepustnica mieszanki i przelotu, 25 - kanal emulsyjny II przelotu. 26 - rurka emulsyjna Il przelotu, 27 - dysza paliwa biegu jałowego I przelotu, 28 - dysza powietrza II przelotu. 29 - dysza powietrza i przelotu. 30 - dysza paliwa biegu jałowego II przelotu, 31 - rurka emulsyjna i przelotu, 32 - kanal emulsyjny i przelotu. 33 - wkręt regulacji prędkości obrotowej biegu jałowego, 34 - otwór wylotowy emulsji przelotu, 35 - komora zmieszania i przelotu, 36 - otwory progresywne wypływu emulsji i przelotu, 37 - przepustnica Il przelotu. 38 - pierścień uszczelniający. 40 - dźwignia przepustnicy mieszanki 11 przelotu. 41 - otwory przejściowe II przelotu, 43 - zaślepka, 67 - śruba dwustronna mocowania filtru powietrza. 68 - zwór elektromagnetyczny. 69 - iglica zaworu

When the mixture throttle is closed and the lever (70) is in the "A" or "B" position, the fuel from the float chamber (6) flows into the starting device via the channel (58) and the starting nozzle (59). The fuel, mixed with the air sucked into the carburetor via the air nozzle (60), flows through the channel (54) into the piston chamber of the starter valve (56), where it is mixed with the air from the channel (55). The mixture is sucked in via the channel (57) to the carburetor passage and allows for easy engine start-up.

When the engine starts to run, the vacuum rises above the throttle, which is transmitted via the channel (63) and opens the valve (62). The additional air supplied through the hole in the bowl (61) impoverishes the mixture in the duct (54), preventing the engine from 'flooding'. Since the engine would be too rich if heated to normal operating temperature, the starter unit must be switched off gradually as the engine temperature rises. This is achieved by closing the channel (57) with the aid of the piston rod (56) until the device is completely switched off when the lever (70) is moved to the "C" position.



2.28. Figure: CONTROL MECHANISM FOR THE SERPENTINE MIX DAMPER

1 - pedal for controlling the throttle of the mixture (gas). 2- Pedal cable, 3 - Pedal cable end, 4 - Intermediate rod, 5 - Intermediate lever cable. 6 - intermediate lever, 7 - pedal return spring, 8 - starter rod. 9 - carburettor, 10 - indirect lever spring. 11 - throttle tendon, 12 - strengthening cap of the pedal frame for controlling the mixture throttle

1 - pedał sterowania przepustnicą mieszanki (gazu). 2- cięgno pedału, 3 - końcówka cięgna pedalu, 4 - drążek pośredni, 5 - cięgno dźwigni pośredniej. 6 - dźwignia pośrednia, 7 - sprężyna powrotna pedału, 8- cięgno urządzenia rozruchowego. 9 - gaźnik, 10 - sprężyna cięgna dźwigni pośrednicj. 11 - cięgno przepustnicy, 12 - nakladka wzmacniająca ramie pedalu sterowania przepustnicą mieszanki

The idling device (Fig. 2.27) operates at low engine speed (closed throttle valves). The fuel from the well with the emulsion pipe (31), flowing through the nozzle (27), is mixed with the air flowing

through the nozzle (29) and in the form of an emulsion it reaches the hole (34) through the channel (32), from where it is directed to the engine's suction pipe. The screw (33) for the idle speed control is placed in the hole (34); it is fixed by the manufacturer with the cap (43) after being adjusted. If the throttle valve is slightly opened, two 0,8 mm diameter holes (36) are switched on, each of which increases the mixture flowing out when the engine speed is increased. Further rotation of the throttle lever causes the throttle valve II to open due to mechanical coupling. Then an emulsion starts to flow from the holes (41) of the idle channel II of the throttle, which is produced by the fuel reaching the well through the nozzle (30) and from the air flowing in through the nozzle (28). The idle and overflight systems are then no longer in operation, as the main dosing and overflight systems are switched on.

The engine is powered from idle system II of the through-flow and through-hole system with three holes of 2 x 1,2 mm and 1,5 mm diameter, allowing it to move gradually from idle to higher, without the risk of the mixture being impoverished to the point where the engine is immobilized.

The idle speed is adjusted only on stage I by turning the screw (19, Fig. 2.24) of the throttle (12). The spigot (11, fig. 2.23) is used to connect the vacuum regulator line of the ignition apparatus.

Carburetors 28/35 S2A1 or 28/35 S2B1 are mounted on the motor suction line with four M8 nuts, screwed onto the stud bolts, screwed into the flange of the cable. Between the carburettor and the cable flange there are two gaskets and one insulating spacer. The carburetor control system is shown in Figure 2.28. The movement of the pedal (1), which is swiveled in a bracket attached to the left footrest of the cab to the two M6 screws, is transmitted to the longitudinal rod (2) at the end (3). This rod is pinned to the intermediate rod (4), which is fixed in two plastic bearings attached to the cab floor support. The horizontal arm of the intermediate rod is attached to the vertical rod (5) of the intermediate lever (6) and damped by the spring (10). The second arm of the intermediate lever (6) is connected to the throttle string (11) and the string is connected to a lever on the throttle axis of the carburetor. The gas pedal (1) is returned to its initial position by the return spring (7). The carburetor starter is controlled by a string (8), which is led to the permanent engine guard in the driver's cab.

To ensure that the throttle is fully open, the pedal stroke (1). shall be 56 mm, measured at its end. The adjustment shall be made by means of the tendon ends (2 and 11) so that, if this condition is met, the spring deflection (10) is at least 3 mm. To ensure that the starter unit is switched off completely, the length of the rod (8) is adjusted so that the handle does not reach its socket after pressing for a distance of 2...3 mm (after the lever has been pressed against the limit stop on the cover of the starter unit for the carburetor).

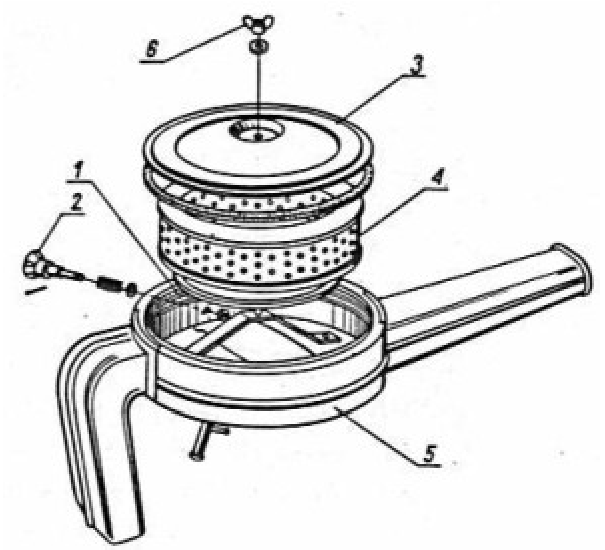
■ The suction line (6, Figure 2.43), which is an aluminium alloy casting, has a piston suction tap on the front branch (12, Figure 2.3) for ventilation of the crankcase (operation discussed in Section 2.1.6). A M14 x 1,5 hole shall be made in the rear branch on the upper plane for the end of the vacuum line of the brake assist system (see 15, Figure 2.43) and a M8 threaded hole shall be made on the front side for attaching the carburetor damper control damper intermediate lever.

The lower wall of the suction pipe (underneath the carburetor mixing chamber) is ribbed (for use with the automatic mixture heater) and has two openings (left and right) to drain excess fuel if the engine is flooded. The internal diameters of the separations are equal to 37 mm.

■ The air filter (Fig. 2.29), dry, with replaceable filter cartridge, is attached to the carburetor with four M5 studs through a rubber gasket and metal plate. Consists of a body (5), a filter insert (4) and a cover (3) fitted with a wing nut (6).

The body is an extrusion made of sheet steel, to which two suction connections (cold and warm air) are fixed by welding, a lockable shutter (1) with a handle (2). The change of the shutter position is performed during the seasonal service (OL, OZ). The total angle at which the handle can be moved from one end position to another is 70°. The motor crankcase venting duct is welded to the lower part of the body and the riveted mounting bracket of the filter cover is riveted.

■ The ring filter element, with an outside diameter of 232 mm and an inside diameter of 182 mm, is made of folded filter paper. The contact surface (3850 cm^2) of the element so constructed ensures good air filtration under average operating conditions (mileage 9000...10 000 km). The air sucked into the filter is purified in the filter cartridge and directed to the carburetor passage I or ll.



1 - sentinel,
2 - iris handle.
3 - filter cover,
4 - filter insert.
5 - corpus,
6 - wing nut

1 - przyslona,
2 - uchwyt przysłony.
3 - pokrywa filtru,
4 - wklad filtracyjny.
5-korpus,
6 - nakrętka skrzydełkowa

2.29. Figure: DRY FILTER CARTRIDGE AIR FILTER

2.1.6 S-21 Lubrication and ventilation system

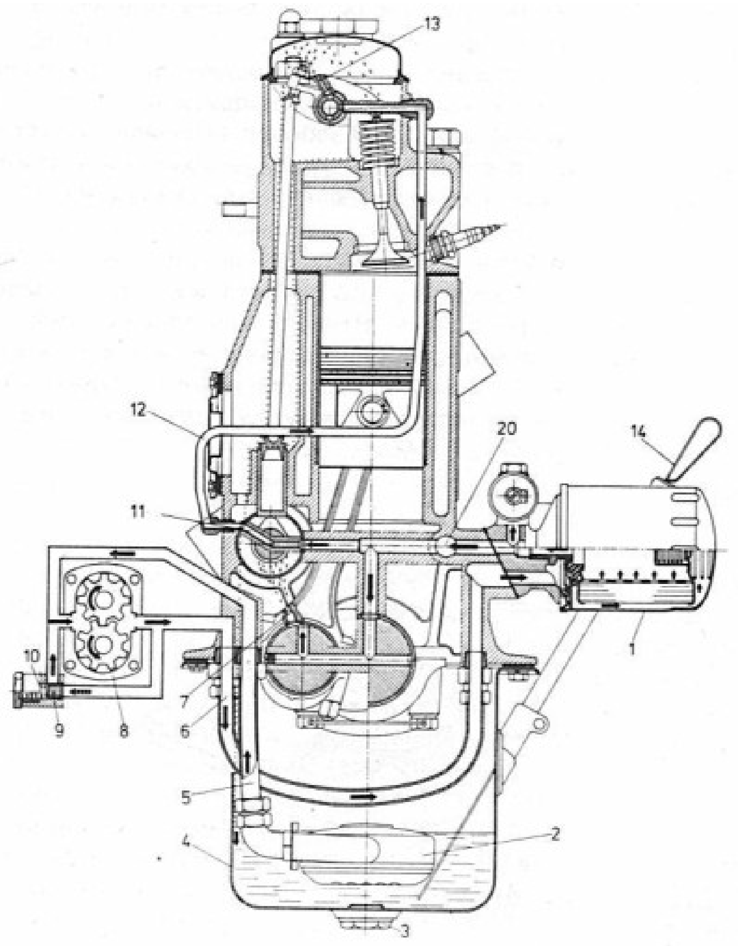
The S-21 engine uses a pressure-spray lubrication system (Fig. 2.30 and 2.31), in which it is used:

- Under pressure, the main bearings of the crankshaft, camshaft bearings, pushers, valve levers and camshaft drive wheels are lubricated;
- The splashes are lubricated by the cylinder liner, pistons, piston pins, camshafts, sprockets and oil pumps, valve stems, bushings in the crankshaft heads and tappet rods in the tappet seats, and valve lever adjustment screws. The basic components of the system are: oil sump (oil tank), oil pump with dragon, full flow oil filter, oil channels and pipes and an oil pressure sensor. The oil filler is located in the head cap and closes with a plug.

The plug (fig. 2.32) consists of a body (2), a gasket (3) and a striker (4) riveted into the body with two rivets. The quantity of oil in the oil sump is checked with a bar measure (14, Fig. 2.30), on which two lines marked with the letters "P" and "0" are punched. They determine the maximum and

minimum level of oil required for normal engine operation. The meter is finished with a handle and a lid with a felt gasket, which allows for tight closing of the inlet. The oil circuit is forced by a gear pump driven by a pair of angular-contact gears from the camshaft. The oil (Fig. 2.30 and 2.31), which is sucked in by the pump (8) via the dragon (2), is pumped through a hose (6) into the oil filter (1). Hence, the channel (20) is distributed through holes in the hull and crankshaft for crankshaft bearings, camshaft bearings and crankshaft bearings. From the third camshaft bearing the oil is pumped via an internal line (12) through the channel in the fourth head bracket to the valve lever axle (17). Lubricated lever bearings are the oil that flows through the internal axle passage and the excess oil flows out through the channels (13). The oil, which falls down through the holes made in the valve lever adjusting screws, is used to lubricate the upper spherical surfaces of the tappet rods and then the lower surfaces of the tappet covers. The camshaft gears are lubricated by a pipe (18) to which oil is fed from the channels (19) of the first camshaft journal. With these channels (twice per revolution of the shaft) the oil is pumped into the pipe (18).

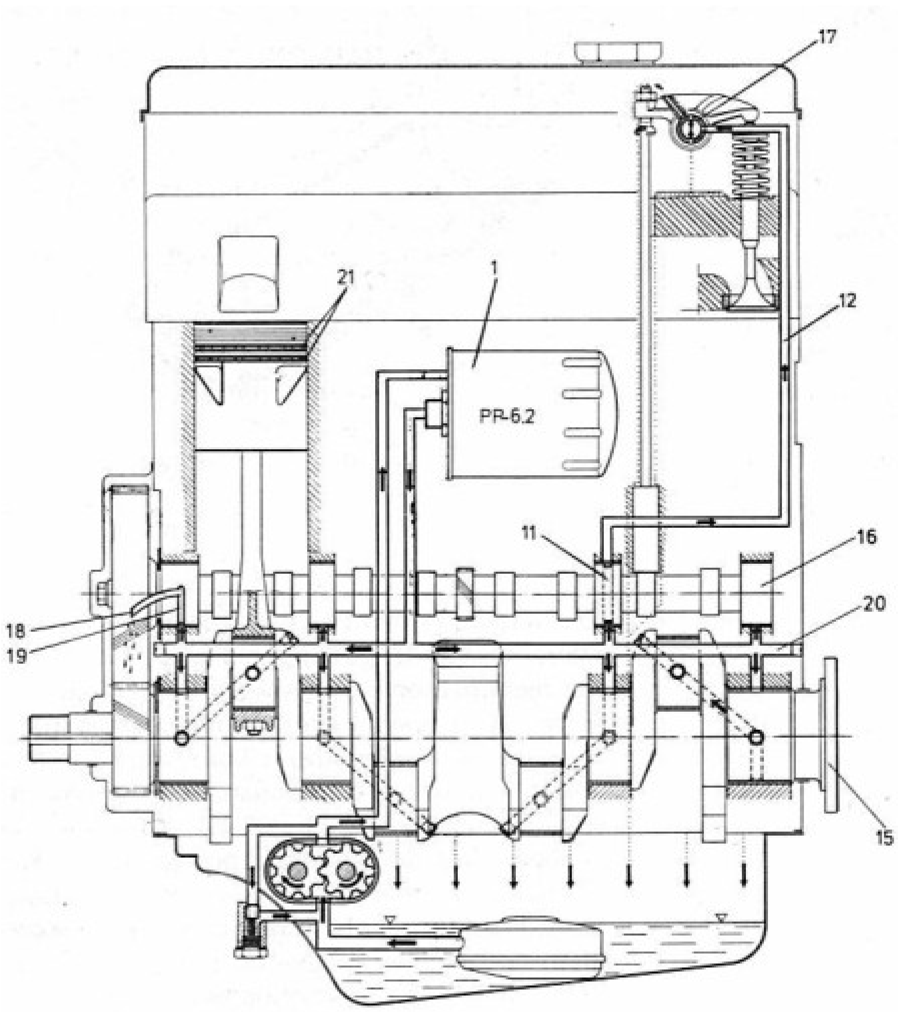
Other friction surfaces are lubricated with oil mist. This is caused by the oil splashing from the oil sump by moving engine parts, which is then pressed out of the pressure-lubricated bearings, collected by the piston scrapers, falling off the head and ejected from the channels (7) in the crankshaft heads.



2.30. Figure: ENGINE LUBRICATION DIAGRAM (TRANSVERSE SECTION OF THE ENGINE)

1 - oil filter,
2 - oil pump dragon.
3 - oil drain plug.
4 - oil sump,
5 - suction pipe,
6 - discharge pipe,
7 - crank duct oil,
8 - oil pump.
9 - piston rod for bypass valve.
10 - bypass valve spring,
11 - oil channel in camshaft journal
3 - oil pipe in valve lever axis,
13 - oxygen channel in valve lever,
14 - oil level gauge,
20 - main oil channel

1 - filtr oleju,
2 - smok pompy oleju.
3 - korek spustu oleju.
4 - miska olejowa,
5 - przewód ssący,
6 - przewód tłoczny,
7- kanał olejowy korbowodu,
8- pompa oleju.
9 - tłoczek zaworu przelewowego.
10 - sprężyna zaworu przelewowego,
11 - kanal olejowy w 3. czopie walu rozrządu,
12 - przewód olejowy osi dźwigni zaworów,
13 - kanal olcjowy w dźwigni zaworu,
14 - miarka poziomu oleju, 20 - glówny kanał olejowy



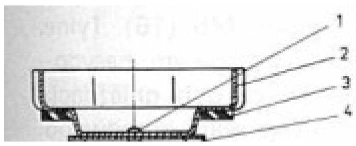
1 - oil filter,
11 - oil channel in the 3rd pin of the camshaft,
12 - oil pipe in the valve lever axis,
15 - crankshaft,
16 - camshaft,
17 - valve lever axis.
18 - camshaft drive wheel lubrication tube.
19 - lubricating channel in the 1st pin of the camshaft shaft,
20 - main oil channel.
21 - piston rings for scraping

1 - filtr oleju,
11 - kanal olejowy w 3. czopie walu rozrządu,
12 - przewód olejowy osi dźwigni zaworów,
15 - wał korbowy,
16 - wał rozrządu,
17 - oś dźwigni zaworów.
18 - rurka smarowania kół napędu rozrządu.
19 - kanal smarowy w 1. czopie walu rozrządu,
20 - główny kanał olejowy.
21 - pierścienie tłokowe zgarniające

2.31. Figure: ENGINE LUBRICATION DIAGRAM (LONGITUDINAL SECTION OF THE ENGINE)

1.- rivet 2 - body, 3 - gasket. 4 – hook

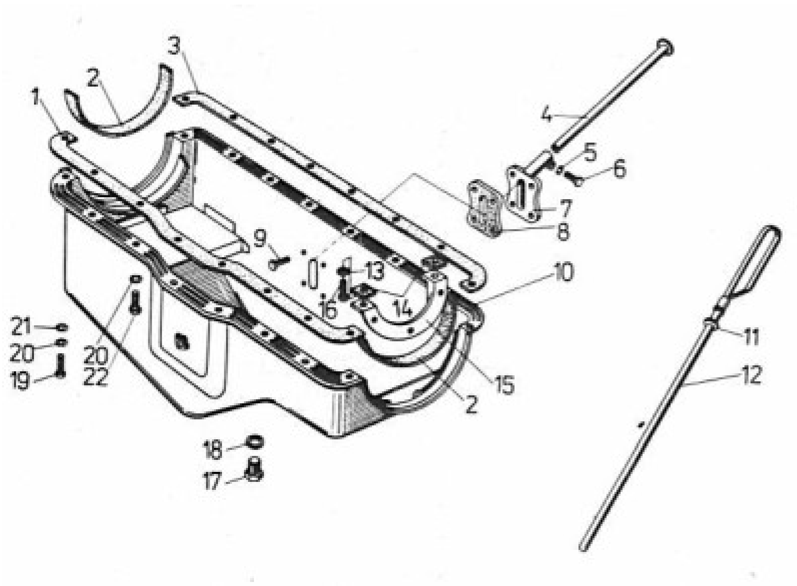
1.- nit. 2 - korpus, 3 - uszczelka. 4 - zaczep



2.32. Figure: OIL FILLER CAP

■ The oil sump (10, Fig. 2.33) is an extrudate made of deep-drawn sheet steel, joined by welding with two horizontal partitions (front and rear), whose task is to dampen oil movements. At the lowest point on the bottom of the bowl is an oil drain hole, closed with a stopper M22 x 1.5 (17) sealed with a fiber washer (18) with a thickness of 2,0 ± 0,25 mm. On the left side of the bowl is screwed in from the inside (for four M6 screws) the socket (7) of the oil level dipstick tube and the riveted end (sealed with a plug with conical thread), which was used to connect the bypass filter outlet, before the introduction of the full-flow oil filter. The crankcase venting oil drain pipe is welded to the front right of the engine. The pipe ends up at the bottom of the bowl near the drain plug. The bowl is sealed with sixteen M8 screws to the bottom edge of the crankcase using two 2,9

± 0,5 mm thick cork gaskets (1 and 3). The first and fourth covers of the crankshaft main bearings are sealed on the circumference with $6^{+0,8}$ mm thick cork seals (2), fitted in two covers (1 mm thick steel sheet); the covers are fixed by welding to the front and rear faces of the bowl. The front gasket is additionally tightened with a half ring (15) screwed to the hull with two M6 screws (16). The rear crankshaft bearing is sealed with asbestos rope, saturated with graphite grease. The rope is placed in two sockets (48, fig. 2.2) which are bolted together with M6 screws and the crankshaft front end is sealed with a Simmer ring in the camshaft cover.

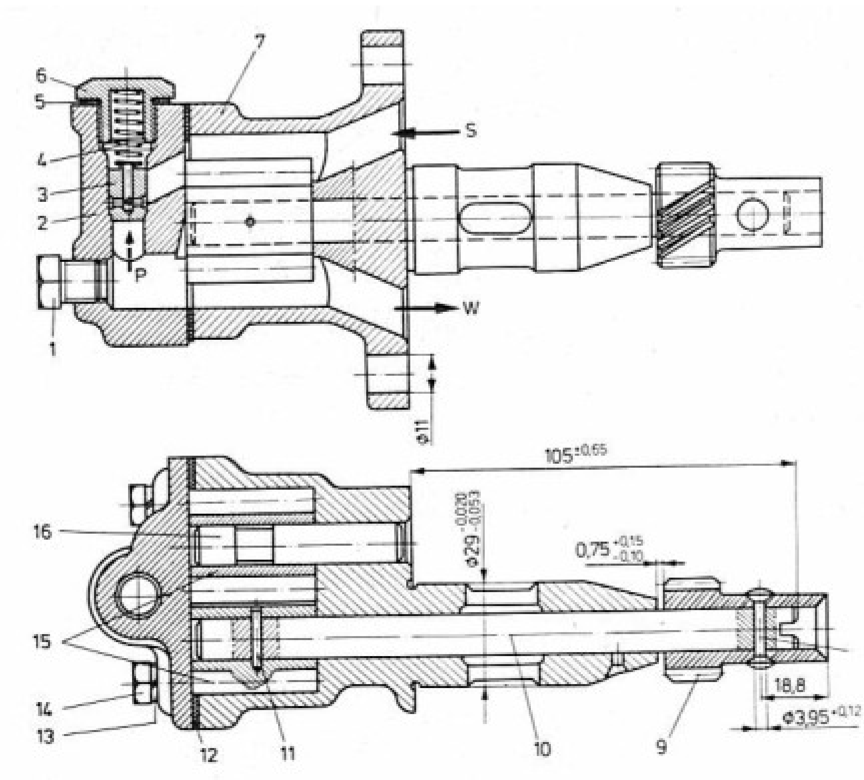


2.33. Figure: OIL SUMP (MISKA OLEJOWA)

1 - right seal of the oil sump. 2 - front and rear seals of the oil sump, 3 - left seal of the oil sump. 4 - oil level dipstick tube, 5, 13 and 20 - spring washers, 6, 9, 16, 19 and 22 - screws and bolts. 7 - oil level dipstick seat, 8 - gasket, 10 - oil sump, 11 - gasket lid, 12 - oil level dipstick, 14. 21 - washers, 15 - front gasket half ring, 17 - drain plug, 18 - drain plug gasket, 7 - front gasket seat, 8 - oil level dipstick, 10 - oil sump, 11 - oil level dipstick, 12 - oil level dipstick, 14. 21 - washers, 15 - front gasket half ring, 17 - drain plug.

1 - uszczelka prawa miski olejowej. 2 - uszczelki przednia i tylna miski olejowej, 3 - uszczelka lewa miski olejowej. 4 - rurka miarki poziomu oleju, 5, 13 oraz 20 - podkładki sprężyste, 6, 9, 16, 19 oraz 22 - śruby i wkręty. 7 - gniazdo miarki poziomu oleju, 8 - uszczelka, 10 - miska olejowa, 11 - pokrywa z uszczelką, 12 - miarka poziomu oleju, 14. 21 - podkładki, 15 - półpierścień uszczelki przedniej, 17 - korek spustowy, 18 - uszczelka korka spustowego

■ The geared oil pump (Fig. 2.34), which is attached to the engine hull by two M10 bolts via an asbestos rubber gasket, is driven from the camshaft by a wheel (9) with the characteristics specified in Table 2-15. The pump consists of a cast iron housing (7) in which they are mounted on a shaft (10), with a diameter of $13^{-0,010}_{-0,022}$ mm, and an axle (16), with a diameter of $13^{-0,064}_{-0,082}$ mm, two identical gears (15). In the cover (2), which is screwed to the body with four M8 screws via a gasket (12) and is 0.2 mm thick, the bypass valve (3.4) is integrated in the piston rod (diameter 11.0 mm). The valve spring characteristics are given in Table 2-17. The pump gear drive (15) is pressed against the retaining bracket (10) and fixed with the pin (11). It works with the second wheel (15), which is swiveled on the axis (16) and pressed into the pump casing. Since the pump drive shaft (10) is coupled with the ignition distributor shaft, which requires a clear operating position, the notch $3^{+0,23}_{+0,18}$ mm wide for the distributor shaft fin is shifted $0,08^{+0,10}_{-0,04}$ mm from the axis of the distributor shaft. The oil drawn in from the oil sump by the dragon (2, Fig. 2.30) is pumped into the oil filter via pipes (5, 6, Fig. 2.30) and channels "S" and "W" in the pump casing, which coincide with the channels in the engine casing. If the pressure on the discharge side (W) rises to 0.35 MPa, the bypass valve spring (4) deflects and the oil is returned to the suction side through an 8 mm diameter "P" channel and circulates in a closed system.



2.34. Figure: OIL PUMP

1 - plug, 2 - cover, 3 - bypass valve piston, 4 - bypass valve spring, 5 - 12 - seals, 6 - bypass valve plug. 7 - pump casing, 8 - rivet 9 - the collected pump drive wheel, 10 - the drive roller. 11 - pin, 12 - pin, gasket, 13 - pad, 14 - bolt, 15 - gears, 16 - pinion of the driving gear, P - overflow channel. S- suction duct. W - pressure channel

1 - korek, 2 - pokrywa, 3 - tloczek zaworu przelewowowego, 4 - sprężyna zaworu przelewowego, 5. 12 - uszczelki, 6 - korek zaworu przelewowego. 7- korpus pompy, 8 - nit. 9 - kolo zebate napędu pompy, 10 - walek napedzający. 11 - kolek, 12 - uszczelka 13 - podkladka, 14 - śruba, 15 - koła zębate, 16 - oś koła zębatego napędzanego, P- kanał przelewowy. S-kanal ssący. W - kanał tłoczny

Number of teeth	10
Diameter of the indexing wheel	24,435 mm
Angle of support	14°30’
Angle of inclination of the tooth screw line	30°
Direction of inclination of the tooth screw line	left

2.15. Table: CHARAKTERYSTYKA KOŁA ZĘBATEGO NAPĘDU POMPY OLEJU

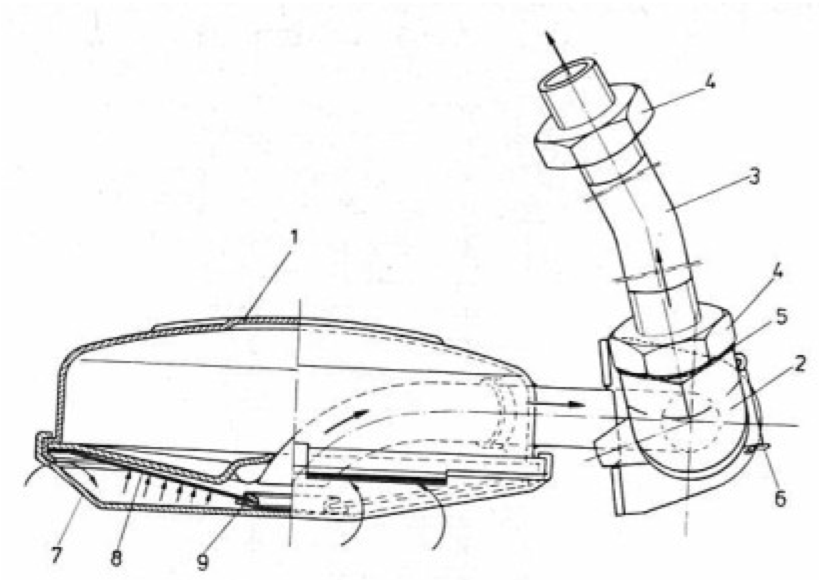
Number of teeth	7
Diameter of the indexing wheel	24,5
Angle of support	25°
Angle of inclination of the tooth screw line	0°
Tooth wheel width	$35^{+0,05}$ mm

2.16. Table: CHARAKTERYSTYKA KÓŁ ZĘBATYCH POMPY OLEJU

Total number of reels	13,5
Number of working coils	11,5
Wire diameter	1,0 mm
Wrapping diameter	5,5 ± 0,25 mm
Height in free height	28,3 mm
Height under load 26,5 ± 3 N	20,0 mm

2.17. Table: SPRING CHARACTERISTICS OF THE OIL PUMP BYPASS VALVE

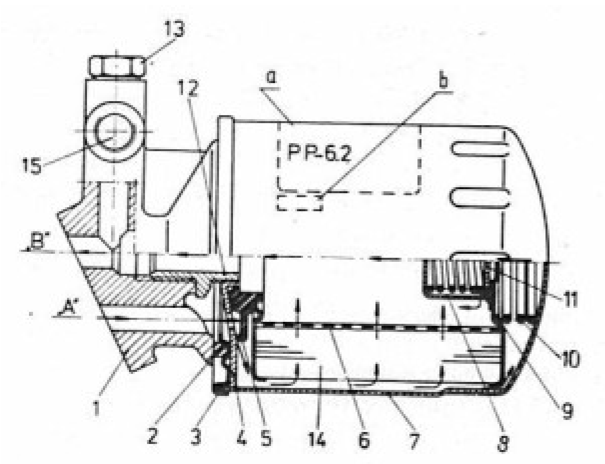
■ The dragon of the oil pump (fig. 2.35) consists of the float (1), the ring (7), the filter grid (8) and the edge of the grid (9). The body of the plate, made of leaded or galvanised sheet steel, is soldered into the body of the plate. The bottom cover and the suction pipe are tightly sealed around the perimeter. A steel mesh with a mesh size of 1,2 × 0,3 mm shall be fitted at the edge of the bottom cover of the float. This grid is used to pre-filter the oil; it has a central hole of 12 mm in diameter, which (in case of grid clogging) supplies the oil to the system without filtering. The dragon is closed with a peripheral ring, which is attached to the body of the float with four clips. The oil is sucked in by circumferential 4 mm high slots formed between the bottom cover of the float and the ring. The dragon, thanks to the float and the rotating seat on the suction pipe, floats on the surface, drawing clean oil (impurities settle on the bottom of the oil sump). The full stroke of the float is 50 mm and is limited from the top and bottom by a bumper at the end (zinc die-cast), connected to a suction pipe (3) screwed into the engine hull to drain the oil into the filter.



1 - float, 2 - end of suction pipe. 3 - suction pipe, 4 - nut, 5 - spring pad, 6 - pin, 7 - ring, 8 - filter mesh, 9 - mesh border

1 - pływak, 2 - końcówka rurki ssącej. 3 - rurka ssąca, 4 - nakrętka, 5 - podkladka sprężysta, 6 - zawleczka, 7 - pierścień, 8 - siatka filtracyjna, 9 - obrzeże siatki

2.35. Figure: OIL PUMP DRAGON (SMOK POMPY OLEJU)



2.36. Figure: OIL FILTER

1 - filter switch. 2 - gasket, 3 - cover, 4 - cover reinforcement. 5 - rubber valve, 6-roller. 7 - body, 8 - plate valve seat. 9 - valve spring, 10 - filter cartridge tensioning spring. 11 - valve plate, 12 - spigot, 13 - plug, 14 - filter insert. 15 - mounting hole for the oil pressure sensor a - information and instruction plate. b - production date indication.

1 - lacznik filtru. 2 - uszczelka, 3 - pokrywa, 4 – wzmocnienie pokrywy. 5 - zawór gumowy, 6-walec. 7- korpus, 8 - gniazdo zaworu płytkowego. 9 - sprężyna zaworu, 10 - sprężyna napinająca wkład filtracyjny. 11 - płytka zaworu, 12 - króciec, 13 - korek, 14 - wkład filtracyjny. 15 - otwór montażowy czujnika ciśnienia oleju a - tabliczka informacyjno-instruktażowa. b- oznaczenie daty produkcji

■ The oil filter PP-6.2 (Fig. 2.36) is attached to the hull by means of a coupling (1) made of aluminium alloy. The oil pressure sensor (4, Fig. 2.2) is screwed into the hole (15) of the coupling. The filter is an undissolvable unit, consisting of a body (7) pressed of steel sheet, rolled tightly at the edge of the cover (3). A welding reinforcement (4) is attached to the cover and serves to connect the filter to the 3/4 inch UNF-2B thread (12).

The filter insert (14), made of 0.2 m2 of filter paper in folded form, is wound onto a perforated sheet metal roller (6) and closed with two covers at the top and bottom.

The spring presses the cartridge against the reinforcement (4) via the rubber valve (5). In the upper cover of the insert, the valve is seated in socket (8), spring (9), plate valve (11). The tightness of the filter, when mounted on the engine, is ensured by the seal (2). The oil pumped through the "A" channel flows through the circumferential holes in the cover reinforcement (4), the valve (5) and the filter insert (14) into the collecting chamber, from where it is discharged through the "B" channel to the main oil channel in the engine hull.

The inlet valve (5) shall have an opening pressure of 11,8 kPa. The volume flow rate through the filter medium at a pressure difference of 80,0 kPa and an oil viscosity of 9,5°E is 0,0078 dm^3/s. The cartridge retains impurities of 15...20 μm. If the filter medium is clogged, oil flows along the casing walls towards the plate valve, which opens at an overpressure of 98.1 ± 19.6 kPa and then flows to the outlet of the "B" cleaner fluid.

Under normal operating conditions, the filter is replaced **every** 9,000 to 10,000 km. Alternatively, the PP-5.4 filter can be used and must be replaced every 6000 km.

S-21 engines use a **closed crankcase ventilation system**. The need to ventilate the crankcase results from the fact that during engine operation a mixture of air-fuel and hot exhaust fumes enters the crankcase. Fuel and fuel vapor dilute the oil and impair its lubricating properties. On the other hand, exhaust gases cause oxidation and decomposition of oil components, and in combination with water vapor they form chemical compounds, which corrode the internal parts of the engine.

In a closed system (Fig. 2.2), gases and oil mist are discharged from the crankcase to the engine's suction system and burned. At high engine speeds, they are mainly extracted via the vent (32) and the tube (29) connected to the air filter (24) into the carburettor. At medium speed, they are extracted via an open valve (section A-A, fig. 2.2) via the same route and hose (26) into the suction line of the motor. At low engine or idle speeds, the gases are only extracted into the air filter, as the valve on the suction line is closed.

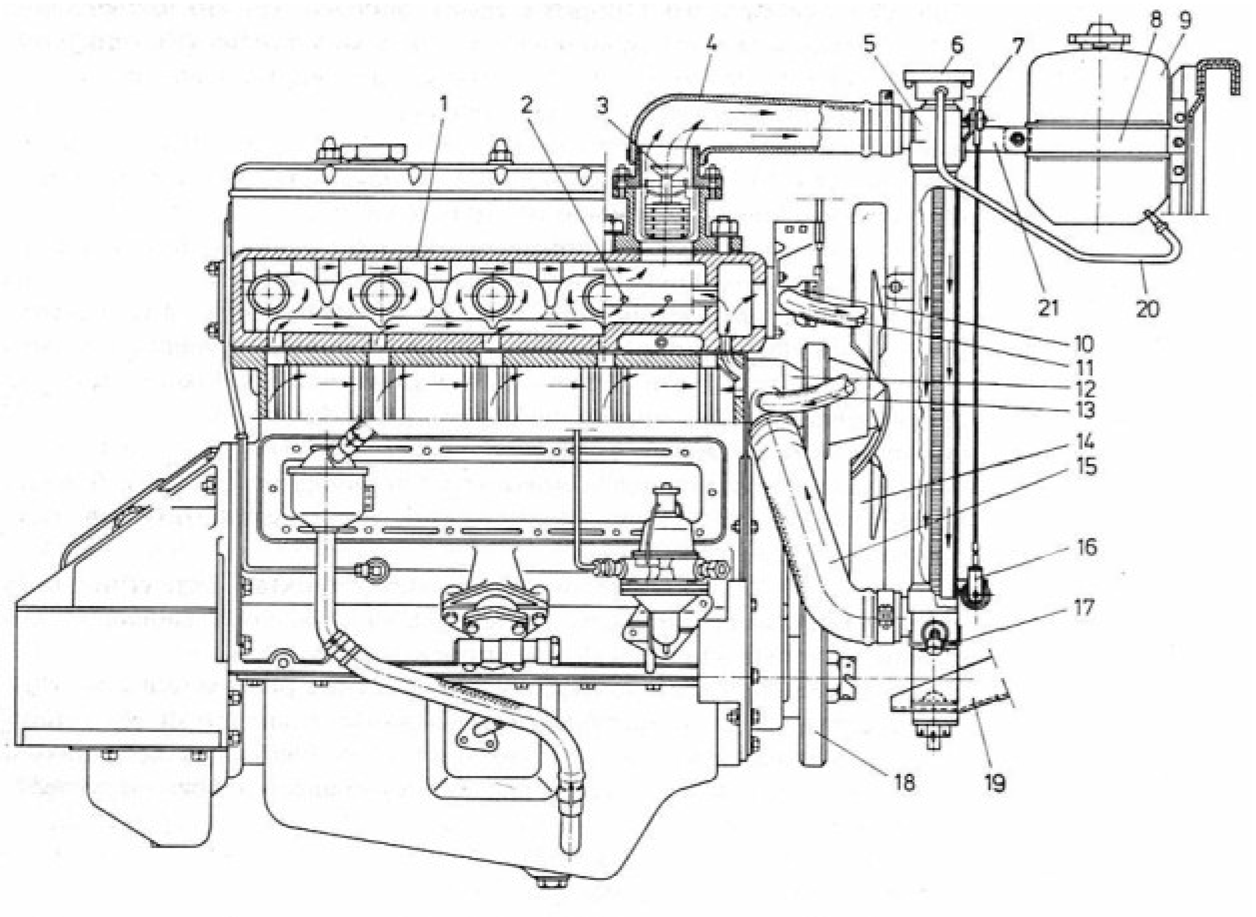
The piston valve is controlled by a lever mounted on the throttle and carburetor passage axes.

The gases, together with the oil mist, are swirled in the vent and decompressed. The precipitated oil settles on the walls and flows down to the oil sump via the pipes (36 and 37). In this way, it is partially recovered and does not create carbon deposits (which would result from its combustion) on the engine head.

In the duct (29) there is a **flame damper** (28), which is a spiral winding of wires, the purpose of which is to prevent flames from the suction pipe to the crankcase in the event of an abnormal combustion process in the engine.

2.1.7 S-21 Cooling system

The S-21 engine has a closed cooling system with a forced cooler circuit. This system (Fig. 2.37) consists of a radiator (5) with an equalising tank (9), a pump (12) with a fan (14), a thermostat (3) and external ducts (4 and 15) and internal ducts in the hull and the engine head.



2.37. Figure: THE ENGINE COOLING SYSTEM

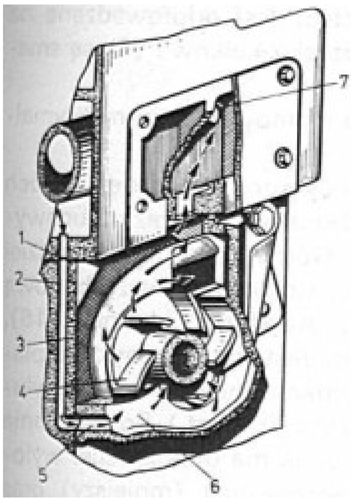
1 - motor heads, 2 - coolant distribution tube, 3 - thermostat. 4 - cable: thermostat casing - top tank of the radiator. 5 - radiator, 6 - filler neck, 7 - radiator shutter strings. 8 - the bracket of the equalisation tank, 9 - the equalisation tank. 10 - system valve heating of the cabin, 11 - line: heating system valve - heater, 12 - cooling system pump, 13 - return line from the heater. 14 - fan, 15 - duct: bottom tank of refrigerator - pump of refrigeration system, 16 - iris of refrigerator. 17 - cooler drain valve. 18 - V-belt. 19 - frame support. 20 - connection cable. 21 - support

1 - glowice silnika, 2 - rurka rozdziału cieczy chłodzącej, 3 - termostat. 4 - przewód: obudowa termostatu-górny zbiornik chłodnicy. 5 - chłodnica, 6 - gardziel wlewu, 7- cięgno przysłony chłodnicy. 8 - obejma zbiornika wyrównawczego, 9 - zbiornik wyrównawczy. 10 - zawór ukladu ogrzewania kabiny, 11 - przewód: zawór układu ogrzewania-nagrzewnica, 12 - pompa układu chłodzenia, 13 - przewód zwrotu cieczy z nagrzewnicy. 14 - wentylator, 15 - przewód: dolny zbiornik chlodnicy-pompa układu chłodzenia, 16 - przysłona chlodnicy. 17 - zawór spustowy cieczy z chłodnicy. 18 - pasek klinowy. 19 - wspornik ramy. 20 - przewód łączący. 21 - wspornik

The system shall be filled with coolant via the condenser filler neck, which shall be closed by a cap (Figure 2.40), and via the filler hole for the equalisation tank (Figure 9, Figure 2.37), which shall be closed by a cap (Figure 2.39), so that its level is 60 to 70 mm above the MIN mark on the wall of the equalisation tank.

Liquid circulation depends on motor temperature. In a cold engine, the liquid circulates "in a so-called small circuit" (Fig. 2.38), without a radiator. The rotor (4) pumps the coolant into the motor housing via a 33 x 28 mm inlet window, from where it flows through the holes in the header header's face in channel 3.5, through the diameter of the pump inlet pipe (6), which sucks it in and circulates it back into the circuit. As soon as the temperature of the liquid rises above 68°C, the thermostat valve opens and the liquid starts to circulate in the so-called large circuit. It flows through the rubber hose (4, Fig. 2.37) to the upper tank of the radiator, flows down the core tubes to the lower tank and is cooled by suction through the hose pump (15, Fig. 2.37) and pressed into the hull channels and into the liquid distribution tube in the head; it cools the walls of the cylinders, combustion chambers and exhaust ducts. When the temperature of the liquid rises to boiling point, at an excess pressure of 49,0 kPa, the outlet valve (7, figure 2.40) of the condenser cap shall open and vapour from the liquid and part of the liquid shall flow into the equalisation tank. When the engine cools down, the system generates a vacuum which, when it reaches 19.6 kPa, opens the non-return valve (8, Fig. 2.40) and the liquid from the equalising tank is sucked back into the system. The pressure in the container shall be compensated for by the valve (2, Figure 2.39) in the stopper for atmospheric pressure. The cooling system used allows the engine to operate at a higher temperature (the boiling point of the liquid corresponds to the overpressure inside the system), and the losses of cooling liquid are small (evaporation losses are constantly supplemented with liquid in the equalisation tank). For this reason, unlike the previous open system, this system can be filled with special fluids, e.g. the Borygo liquid, which is difficult to freeze.

Regardless of the described coolant circuits, the cabin heating circuit is still activated by a valve (10, Fig. 2.37) located on the head (1). The liquid flows through the flexible hoses (11) to the two heaters and returns via the hoses (13) to the suction side of the pump. Two drain valves are used to drain the cooling system: one (17) located to the right of the lower tank of the radiator and the other (14, Figure 2.1) to the left of the lower shell of the hull.



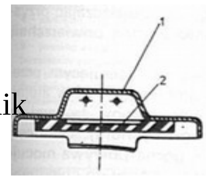
2.38. Figure: THE COOLANT CIRCUIT IN THE COLD ENGINE

1 - head, 2 - motor hull, 3 - vertical duct. 4 - cooling system pump impeller, 5 - horizontal duct. 6 - Pump inlet line. 7 - Coolant and coolant separation tube

1 - glowica, 2 - kadłub silnika, 3 - kanał pionowy. 4 - wirnik pompy układu chłodzenia, 5 - kanal poziomy. 6 - przewód wlotowy pompy. 7 - rurka rozdziału cieczy chłodzacei

1 - housing,
2 - gasket (valve)

1 - obudowa,
2 - uszczelka (zawór)

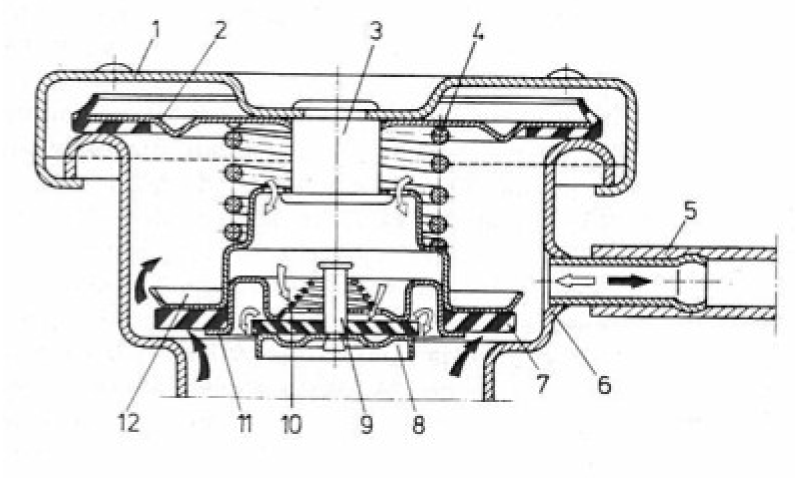


2.39. Figure: EQUALISING TANK CAP

■ The centrifugal pump of the cooling system (Fig. 2.41) is attached to the front wall of the engine hull with three M10 bolts, consisting of an aluminium casing (1), a shaft (14) bearing in two bearings (6), a cast iron rotor (13) is pressed onto the shaft and fixed with a corrugated pin (9) of the pulley hub (8). The impeller has radial, straight blades (8 pcs.) with a fixed height and a claw clutch (15) for the sealant. A sealant (type Morpak or Cyclam), combined with a resistance insert (2) seated in a rubber seat (3), protects the bearings (6) from the effects of coolant. During operation, the ceramic plate of the sealant (11) is pressed against the

thrust insert (2) by the internal spring of the sealant and forms a tight movable connection. In the event of a loss of tightness in the connection, the liquid that has entered is drained off through the opening (a) in the pump casing. The ball bearings (6) are lubricated with a grease nipple (5).

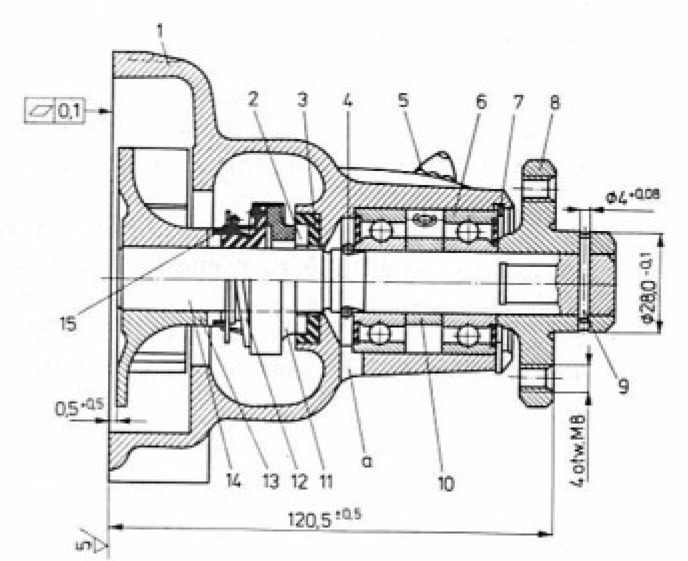
The pump capacity (volumetric flow rate) is a maximum of 2.3 dm^3/s at liquid temperature of 80°C.



2.40. Figure: RADIATOR CAP

1 - body, 2 - gasket, 3 - stem. 4 - outlet valve spring, 5-supply line, 6 - radiator filler neck, 7 - outlet valve gasket, 8 - non-return valve plate, 9 - non-return valve stem. 10 - check valve spring. 11 - non-return valve seat, 12 - outlet valve plug

1 - korpus, 2 - uszczelka, 3 - trzpien. 4 - sprężyna zaworu wylotowego, 5-przewód dopływowy, 6 - gardziel wlewu chłodnicy, 7- uszczelka zaworu wylotowego, 8 – płytka zaworu zwrotnego, 9 - trzpień zaworu zwrotnego. 10 - sprężyna zaworu zwrotnego. 11 - gniazdo zaworu zwrotnego, 12 - grzybek zaworu wylotowego



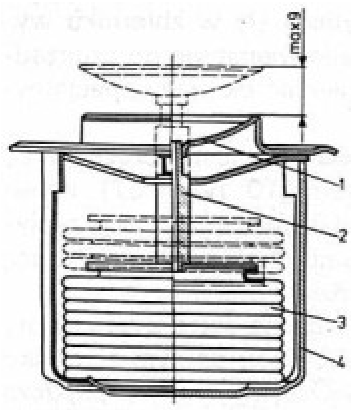
2.41. Figure: COOLING SYSTEM PUMP

1 - body, 2 - thrust pad, 3 - thrust pad socket, 3 - thrust pad. 4 - bearing retaining ring. 5 - Lubrication nipple, 6 - Tożysko, 7 - expansion ring. 8 - the pump drive pulley pulley hub, 9 - the pulley pin 10 - the spacer sleeve. 11 - sealing plate, 12 - spring. 13 - rotor, 14 - rotor shaft, 15 - collector, a - liquid drainage hole

1 - korpus, 2-wkladka oporowa, 3- gniazdo wkladki, oporowej. 4 - pierścień oporowy łożyska. 5 - Smarowniczka, 6 - Tożysko, 7 - pierścień rozprężny. 8 - piasta kola pasowego napędu pompy, 9 - kolek 10 - tuleja odległościowa. 11 - płytka uszczelniacza, 12 - sprężyna. 13 - wirnik, 14 - wałek wirnika, 15 - zabierak, a - otwór spływowy cieczy

■ The radiator (5, Fig. 2.37), of the tube-belt type, consists of two receptacles: the upper and lower, the core and the lateral flanges with the handles and supports of the radiator shutter-plate (16). The upper tank has a filler neck (6) with a lockable cap, an inlet port for connection to the thermostat casing and a tendon armour holder (7) for the radiator shutter (16). The heat exchanger core is made up of 66 flat tubes arranged vertically in two rows, between which copper cooling tubes are soldered (64 pcs.). The active surface of the heat exchanger is 8,5 m^2. The lower tank has two connections: the outlet tube (larger) and the return tube on the left heater (smaller) and the bracket for mounting the cooler. The radiator is flexibly fixed at three points: to the body cab by means of two rubber/woven belts and to the frame bracket (19) on two rubber cushions by means of an M10

screw; the iris (16) of rubberized fabric, rolled up on a roller and held in place by an internal spring, allows current regulation of the temperature of the liquid in the cooling system. Lifting or lowering the shutter-plate (by means of a tendon) changes the active surface of the radiator accordingly. The capacity of the radiator is 2,45 dm^3.



1 - mushroom valve,
2 - spindle,
3 - liquid tank,
4 - housing

1 - zawór grzybkowy,
2 - trzpień,
3 - zbiorniczek cieczy,
4 - obudowa

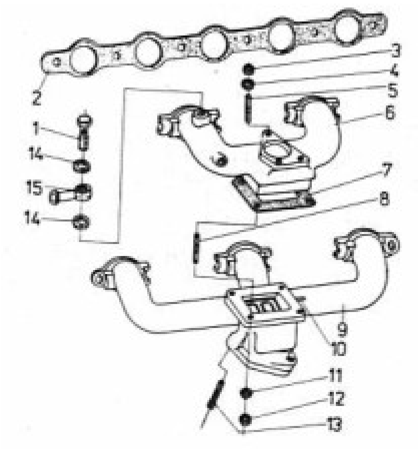
2.42. Figure: LIQUID THERMOSTAT

■ The thermostat (Fig. 2.42) is an automatic valve that controls the coolant flow from the motor to the radiator. It is placed in an aluminium housing which is screwed (through the gasket) with two screws to the engine head (above the spark plug of the first cylinder). The thermostat housing is connected to the head channels. Its upper cover fixes the thermostat and at the same time provides a drainage outlet for the liquid to the radiator. The thermostat consists of a mushroom valve (1) with a diameter of 34 mm, a pin (2), attached to the upper cover of a 44,5 mm diameter brass tank (3), the bottom of which is soldered to the housing (4). There is a mixture of low evaporation liquids in the tank. When the temperature of the coolant in the system rises, the liquid mixture in the thermostat evaporates and expands the tanks axially by increasing its volume. As a result of lifting. the mushroom valve opens and the hot liquid flows into the radiator. The maximum valve lift is 9 mm and can be reached when the temperature of the liquid rises to 78...83°C. The valve starts to open at a temperature of 68 to 74°C. The thermostat is an undissolvable component. To control the temperature of the liquid in the cooling system, a sensor is used, screwed onto a conical thread on the left side of the head, giving impulses recorded on the indicator, placed on the board in the driver's cab. The cooling system pump, the four-vane fan (28, 2.3) and the alternator are driven by two pulleys made of sheet steel: one pulley mounted on the crankshaft of the engine (33, 2.3) and the other pulled on the pump shaft (29, 2.3) and a rubber/woven V-belt measuring 17 x 11 x 1060 mm.

2.1.8 S-21 Exhaust system

The exhaust system for the evacuation of exhaust gases and for the suppression of noise caused by their discharge shall consist of an exhaust pipe with a mixture heater, an exhaust pipe and a silencer.

2.1.8 S-21 Exhaust system



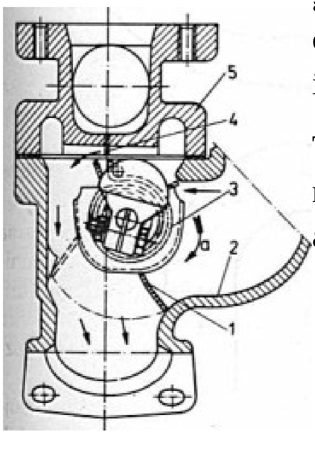
2.43. Figure: INTAKE-EXPIRATORY (PRZEWOD SSĄCO-WYDECHOWY)

1- Hollow bolt of the end of the vacuum line of the brake booster system, 2 - Gasket of the suction line, 3, 12 - nuts, 4 - pads, 5, 8 - stud bolts. 6 - suction line, 7. 14 - seals, 9 - exhaust line, 10 - throttle axis of the mixture heater, 11 - spring washer, 13 - stud bolt, 15 - end of vacuum line of the brake system support system

1- Śruba drążona końcówki przewodu podciśnieniowego mechanizmu wspomagania układu hamulcowego, 2 - Uszczelka przewodu ssącowydechowego, 3, 12 - nakrętki, 4 - podkladki, 5, 8 - śruby dwustronne. 6 - przewód ssący, 7. 14 - uszczelki, 9- przewód wydechowy, 10 - oś przepustnicy podgrzewacza mieszanki, 11 - podkładka sprężysta, 13 - śruba dwustronna, 15 - końcówka przewodu podciśnieniowego mechanizmu wspomagania ukladu hamulcowego

■ The exhaust pipe (9, Fig. 2.43), cast in heat-resistant cast iron, has three branches (one outer branch from the 1st and 4th cylinders and one central branch from the 2nd and 3rd cylinders), which connect at the outlet with the collecting chamber in which the mixture heater is integrated. The construction and operation of the heater is shown in Figure 2.44. A throttle (1) is mounted on the axis of the cable in the walls on two stainless steel sleeves. At the end of this axis, a bimetallic spiral spring (3) and a counterweight are mounted on the outside of the wall of the collecting chamber. The spring is fitted with a preload. If the engine is cold, the throttle takes up the position marked in the figure with a continuous line. By washing the lower wall of the suction line, the combustion gases heat up the fuel mixture. As the engine temperature rises, the bimetallic spring deforms, causing the throttle to rotate in the direction of arrow (a), thus limiting the supply of flue gases to wash the suction line. At the end of the damper blade (dotted line in the figure) the exhaust gases are directed directly to the exhaust pipe. This process is carried out automatically, improving the efficiency of engine operation in the initial period after its start-up (easier evaporation of fuel).

The exhaust line shall be connected together with the suction line by means of an asbestos rubber gasket with a steel frame (2, Figure 2.43) attached to the engine head by six stud bolts and nuts M10 x 1.



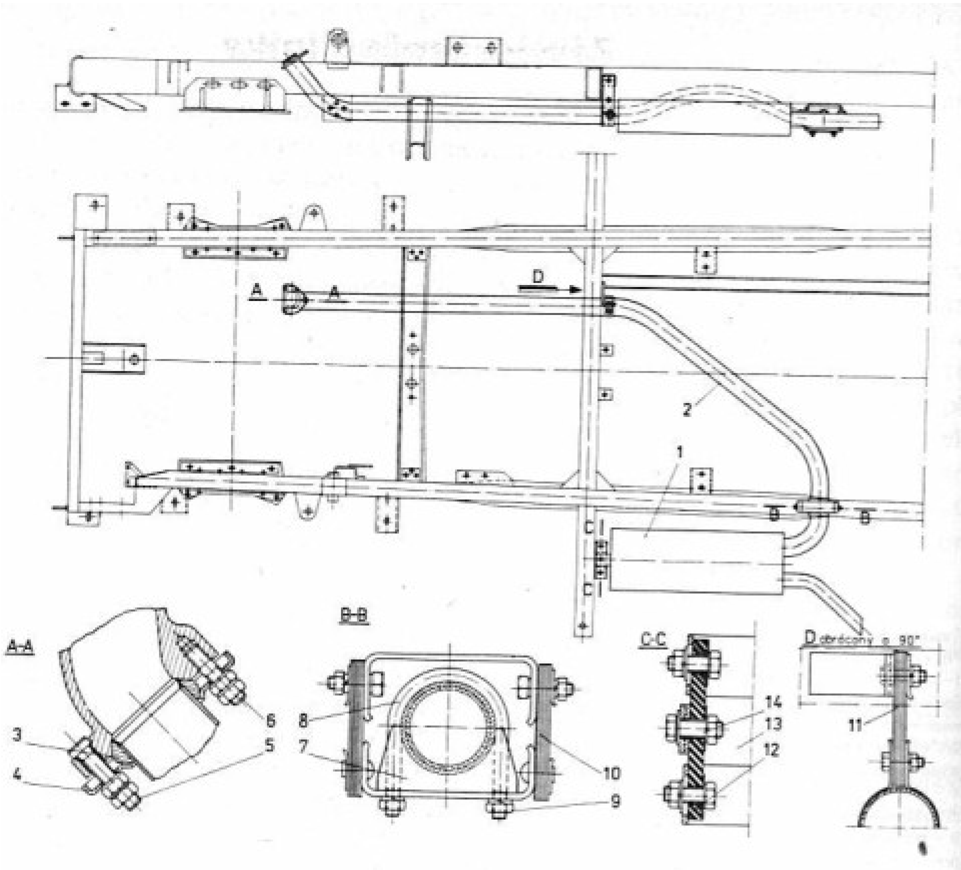
2.44. Figure: MIXTURE WARMER

1 - damper blade, 2 - exhaust pipe, 3 - bimetallic spring, 4 - fuel drain hole, 5 - suction pipe

1 - przepustnica, 2 - przewód wydechowy, 3 - sprężyna bimetalowa, 4- otworek ściekowy paliwa, 5 - przewód ssący

■ The exhaust pipe (2, Figure 2.45) is bolted to the outlet of the exhaust pipe collecting chamber using three bolts (5 and 6) and brass nuts M10 and M10 x 1. The joint is tightened by a ring (3) welded to the end of the pipe and clamped into the conical sockets of the exhaust pipe and the pressure flange (4). The exhaust pipe, which forms a single unit, is suspended from the car frame on two rubber and textile hangers. The mounting method is shown in cross-section B-B (double hanger) and in view D (single hanger). The tightness

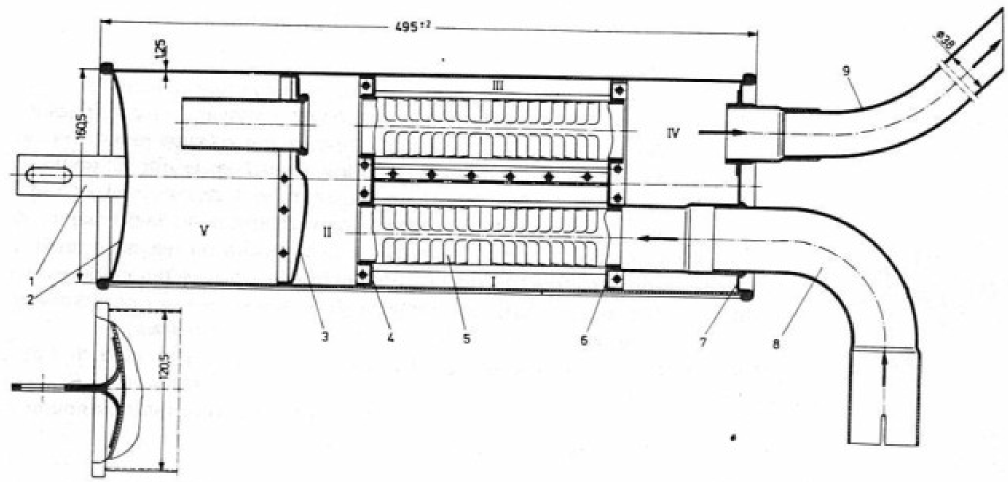
of the exhaust pipe connection to the silencer inlet pipe (1) is ensured by the yoke (7), bolted to the stirrup (8) using M8 nuts (9).



1 - silencer, 2 - exhaust pipe, 3 - sealing ring, 4 - clamping collar. 5, 14 - screws. 6 - stud bolt, 7 - yoke, 8 - stirrup, 9 - nut, 10 - double hanger belt. 11 - single hanger belt, 12 - divider belt. 13 – handle

1 - tłumik, 2 - rura wydechowa, 3 - pierścień uszczelniający, 4 - kolnierz dociskowy. 5, 14 - śruby. 6 - śruba dwustronna, 7 - jarzmo, 8 - strzemię, 9 - nakrętka, 10 - pas wieszaka podwójnego. 11 - pas wieszaka pojedynczego, 12 - przekładka. 13 - uchwyt

2.45. Figure: EXHAUST SYSTEM



1 - bracket, 2 - front cover, 3 - partition of resonance chamber. 4.6 - expansion chamber bulkheads, 5 - perforated pipe, 7 - rear cover, 8 - inlet pipe, 9 - outlet pipe

1 - wspornik, 2 - pokrywa przednia, 3 - przegroda komory rezonansowej. 4.6 - przegrody komór rozprężnych, 5 - rura perforowana, 7 - pokrywa tylna, 8 - rura wlotowa, 9 - rura wylotowa

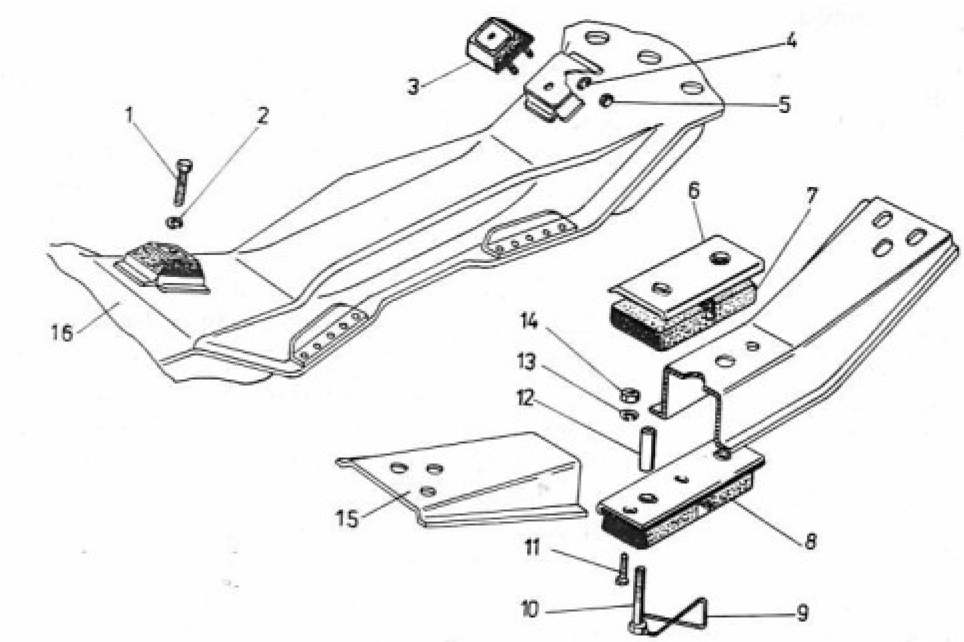
2.46. Figure: EXHAUST SILENCER (TŁUMIK WYDECHU)

■ The exhaust silencer (Figure 2.46) of the labyrinth type is a metal container (elliptical in cross-section) closed with two lids. The inlet (8) and outlet (9) pipes are welded in the rear cover (7) and the bracket (1) in the front (2). The method of fixing the silencer to the car frame through the rubber/woven spacer (12) is shown on the C-C cross-section (Fig. 2.45). Oval holes in the frame holder (13) and in the damper support make it possible to adjust the frame position. The inner space

of the silencer is divided into four expansion and reflection chambers: I, II, III, IV and one resonance V. The flue gases in the first three chambers expand, losing speed. The resonance chamber extinguishes the flue gas pulsation and silences the exhaust pipe outlet (9) from the expansion chamber IV. The latest design of the exhaust system uses the silencer described in section 2.2.8.

2.1.9 S-21 Suspension

The engine is hung flexibly in the car frame at three points on rubber cushions (Fig. 2.47). Two front cushions are attached to the front suspension beam (16) and the rear cushions are attached to the clutch housing and the crossbar (15). The front cushions (3) are in the shape of truncated pyramids. At the bottom, there are vulcanized plates with two M8 x 1 screws, at the top, there is a plate with M12 threaded hole and a 5 mm diameter base pin.



2.47. Figure: ENGINE MOUNT - FIXING AND DAMPING PARTS

1,10,11 - screws. 2. 4. 13 - spring washers, 3 - front suspension cushion, 5. 14 - nuts. 6 - protective cap for rear suspension cushion. 7 - rear suspension top cushion, 8 - rear suspension bottom cushion, 9 - safety wire. 12 - distance sleeve. 15 - rear motor mounting bar. 16 front suspension ball

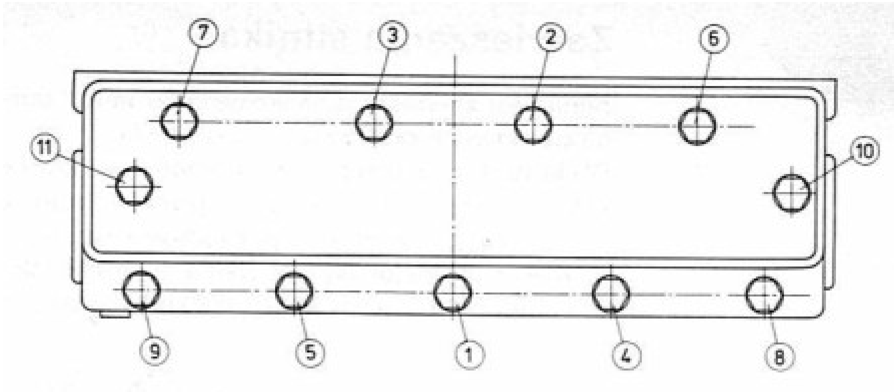
1,10,11 – śruby. 2. 4. 13 - podkładki Sprężyste, 3 - poduszka przedniego zawieszenia, 5. 14 - nakrętki. 6 - nakladka ochronna poduszki tylnego zawieszenia. 7 - poduszka górna tylnego zawieszenia, 8 - poduszka dolna tylnego zawieszenia, 9 - drut zabezpieczający. 12 - tulejka odległościowa. 15 - tylna poprzeczka mocowania silnika. 16- belka przedniego zawieszenia

The rear suspension consists of a rubber top cushion (7) with a protective cap (6) and a lower rubber metal top cushion (8), bolted from the middle to the motor mounting crossbar with three M8 bolts, the upper cushion being over the cross cushion and bolted together with the lower cushion and the coupling casing by means of distance sleeves (12) 47 mm long with two M12 x 70 screws, the bolts being secured against loosening with a wire (9) 1.6 mm in diameter. The described method of suspension allows for effective damping of the natural and forced vibrations of the motor.

2.1.10 S-21 Maintenance

The basic prerequisite for maintaining high technical efficiency of the engine is strict observance of the rules and dates of performing maintenance.

Hull and head operation is limited to maintaining clean external surfaces, checking the tightness of connections, removing carbon from combustion chambers and removing boiler scale from hull and head cooling spaces.



2.48. Figure: TIGHTENING SEQUENCE OF HEAD FIXING SCREWS

Keeping the outside surfaces of the engine clean allows early detection of cracks, leaks and leaks in connections. After the nuts and bolts have loosened, or at the latest after the first 1500 ± 200 km, tighten the nuts and bolts that secure the motor accessory and the bolts that secure the head (on the cold engine) using a torque wrench, in the order shown in Figure 2.48. The tightening torque for the head bolts is 108...118 N·m. The presence of flue gases underneath the head or of a coolant in the oil sump usually indicates that the head gasket has been damaged. In this case, it is essential to replace the gasket as quickly as possible. To do this, remove the head (without removing the motor from the frame), clean the contact surface, replace the gasket, apply a thin layer of engine oil or graphite powder to the head and reinstall the head by tightening the screws as shown. If coolant is detected in the oil sump, it is essential to change the oil.

Each head disassembly should be used to remove carbon from the combustion chambers. Cleaning of combustion chambers is carried out using scrapers and wire brushes, taking care not to scratch the cleaned areas excessively. If the piston crown, valves and exhaust ducts in the engine head are also subjected to carbon removal, it is advisable to replace the engine oil after washing and drying these areas. Stone from the cooling system and the boiler head must be removed after every 27 000 km or in case of overheating of the engine (measures and procedures are discussed later in this chapter).

The adjustment of valve lashings is a basic activity during the operation of the camshaft. It shall be performed as soon as the following symptoms are detected in the engine operation: difficult starting, irregular operation, blowing of the exhaust gas into the suction line ("sneezing" into the carburettor) or afterburning of the mixture in the exhaust pipe ("shots" into the silencer), excessive noise in the operation of the timing mechanism (and after each tightening of the bolts, disassembly and assembly of the head).

Checking and adjusting must be carried out on a cold engine, observing the recommended clearance values for the suction and exhaust valves. The clearance is measured by measuring the gap between the stem of a fully closed valve and the end of the valve lever.

The play adjustment is carried out as follows:

- by turning the crankshaft clockwise (using the crank handle) position the piston of the 1st cylinder (after the compression stroke has been completed) in the outer turn (the indicator in the sight glass of the clutch housing shall be located in front of the drilling with the ZZ

mark on the flywheel (Fig. 2.14); both valves of the 1st cylinder are closed in this position; exhaust valve of the 2nd cylinder and exhaust valve of the 3rd cylinder are closed as well;

- slide a gap gauge between the exhaust and suction valve handles of these cylinders and the valve levers and check the clearance values;
- if the clearances are incorrect, the clearance should be adjusted to the required value by turning the adjusting screw using a screwdriver and a ring spanner (if the clevisness is spaced correctly, the thickness gauge should move with a slight resistance);
- after adjusting the play and securing the screws with counter nuts, turn the shaft fully (360°) so that the indicator in the sight glass of the coupling casing is again in front of the drilling with the ZZ mark on the flywheel; then, the clearances of the suction and exhaust valves should be adjusted 4. the cylinder and suction valve of the 2. cylinder and the exhaust 3. the cylinder.

Valve clearances can be adjusted separately for each cylinder. For this purpose, after adjusting the valve lash adjustment of the 1st cylinder, the crankshaft must be rotated 180° each time from the position where the 1st cylinder piston was in the exterior turn after the compression stroke. The adjustment of the valve lashages according to the given rules should be carried out in these positions of the crankshaft, successively for valves 2., 4. and 3.

Reduced backlash is the reason why valves do not close when the engine reaches normal operating temperature, when the compression pressure decreases and therefore the power decreases, and when the backlash is reduced, the unburnt mixture in the suction or exhaust pipe explodes. Exhaust gas blows through the valve, which is not closed, quickly burn out the valve's doorsteps.

Excessive backlash increases the noise level of the valve train and increases the wear and tear of its components due to additional dynamic loads.

■ Supply system operation. Taking care of the correct condition and proper regulation of the power supply system has a crucial influence on the efficiency of motor operation. Filling the car's tank with fuel is a periodic process that must be carried out with great care (fire hazard, poisoning with lead tetraethyl in addition to the fuel) and under conditions that guarantee maximum cleanliness. Contaminants and water in the fuel tank cause uneven engine operation and require cleaning of the entire power supply system.

The operation of the fuel tank is limited to periodical (e.g. during seasonal operation) removal of sediments by draining the entire tank content with a drain hole. After filtering through a dense mesh filter, contaminated fuel can be used for further operation. It is also advisable, when cleaning the tank, to remove the fuel dragon from it and blow out the filtration net with compressed air. In order to prevent the tank from becoming under-pressurised as a result of a drop in fuel levels (which may lead to stoppages in operation or even a stoppage of the engine while the vehicle is moving), the ventilation opening in the filler cap must be kept open.

The fuel pump is operated by periodic cleaning of the settling tank. To do this, unscrew the winged nut of the yoke (12, fig. 2.20), fold it out and remove the glass (10, fig. 2.20). The glass should be cleaned, the upper part of the pump casing should be washed with clean gasoline, and then the

whole glass (including the filter) should be blown off with compressed air. After assembly, the pump and the float chamber of the carburetor must be filled with a manual lever (25, fig. 2.20), ensuring that the connections are tight.

Operation of the carburetor is limited to adjustment and periodic cleaning. The basic control elements of 28/35 S2A1 or 28/35 S2B1 carburetors (for S-21 engine) and 3452C16 carburetors (for CB engine) are given in Table 2-18. The float drift and the idling speed of the drift are regulated periodically. The fuel level in the float chamber of carburetor 28/35S2A1 or 28/35S2B1 shall be adjusted by bending the tongue of the float hinge (6, Figure 2.49) to give a dimension of 6,25...6,75 or 6,25...7,25 mm and the stop (3) to give a full float stroke of 13,5 mm. The adjustment should be made after 9000 km or if necessary.

Also clean the carburetor at the same intervals. For this purpose, it is recommended to remove the carburetor from the engine and partially disassemble it.

Carburetor variety	**28/35S2A1**		**28/35S2B1**		**34S2C16**	
Przelot	I	I1	I	I1	I	I1
Main dosing unit						
Garrison	21	26	21	26	24	26
Sprayer	4,5	4,5	4,5	4,5	4,5	4,5
Fuel nozzle	110	145	110	125	115	140
Air nozzle	250	225	250	220	230	200
Emulsion tube	F27	F35	F27	F35	F35	F30
No-load device and transient system						
Fuel nozzle	45	100	45	50	100	100
Air nozzle	175	80	175	80	160	80
Mixture nozzle	170	-	170	-	150	-
Temporary opening 1.	80	120	80	120	90	120
Temporary opening 2.	80	120	80	120	90	120
Temporary opening 3.	-	150	-	150	80	150
Temporary opening 4.	-	-	-	-	80	-
ZHS - mix opening	-	-	-	-	80	-
Accelerator pump						
Nozzle	40		40		50	
Valve	80		80		closed	
Jump (mm)	10		10		13	
Expenditure (cm^3/10 jumps)	5		5		15	

2.18. Table: REGULATORY DATA OF CARBURETORS

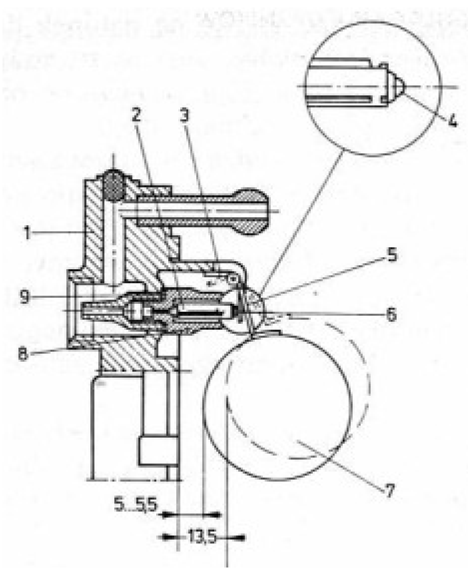
Carburetor variety	**28/35S2A1**		**28/35S2B1**		**34S2C16**	
Przelot	I	I1	I	I1	I	I1
Starter						
Fuel nozzle	F1/150		F1/150		F1/150	
Air nozzle	150		150		150	
Actuating air opening	5,75		5,75		6,0	
Depleting borehole 1.	1,75		1,75		3,5	
Depleting borehole 2.	1,75		1,75		2,0	

Carburetor variety	**28/35S2A1**	**28/35S2B1**		**34S2C16**	
Spare manhole sleeve	250	250		250	
Saver Fuel nozzle Sprayer	 - -	 - -	 80 2,5	 - -	 90 2,5
Float equipment Needle valve Float weight (g) Float distance from the plane cover (without seal) in mm	 175 17,5...18,5 6,25...6,75	 175 17,5...18,5 6,75...7,25		 175 17,5...18,5 7,75...8,25	
Note: Nozzle features are 100 times larger than nozzle diameter; e.g. nozzle with 120 has a real hole dimension of 1,2.					

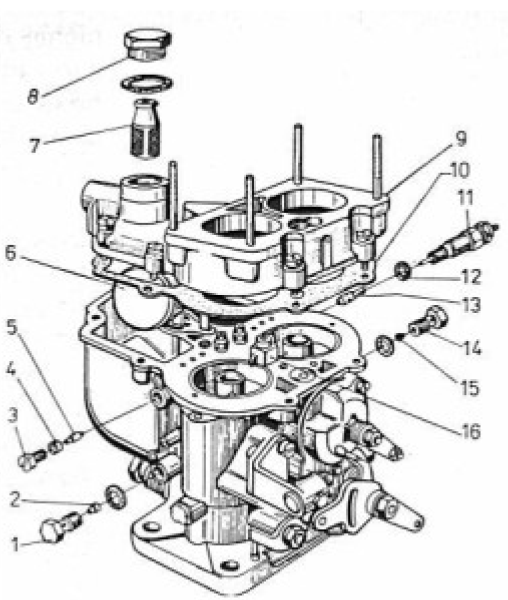
Removal (fig. 2.50) includes removal of carburetor cover (9), removal of main nozzles (2 and 15), idling nozzle (5) for Passage quantity and nozzle (13), solenoid valve (11) for passage, accelerator pump injector (16) and removal of mesh filter (7), after removal of plug (8). Wash all carburetors and dismantled parts with kerosene or clean gasoline and blow off with compressed air. Nozzles may not be swallowed with steel objects due to the fact that they can be dismantled.

1 - carburetor cover, 2 - firing pin valve, 3 - stroke limiter, 4 - firing pin vibration damper, 5 - float hinge, 6 - float hinge tongue, 7 - float, 8 - valve body, 9 - padding

1 - pokrywa gaźnika, 2 - zawór iglicowy, 3 - ogranicznik skoku, 4- amortyzator drgań iglicy, 5- zawiasa pływaka, 6 - języczek zawiasy pływaka, 7 - pływak, 8 - korpus zaworu, 9 - podkladka



2.49. Figure: CARBURETOR 28/35 S2A1 - REGULATION OF FUEL LEVEL IN THE FLOAT CHAMBER



2.50. Figure: CARBURETOR 28/35 S2A1 - PERMISSIBLE DISMANTLING

1.14 - fuel nozzle outlets 1 and 2 throughput, 2.15 - fuel nozzles 1 and 2 throughput, 3 - fuel nozzle outlet 1 throughput, 4.12 - sealing rings. 5.13 - idling fuel nozzles, 6 - float, 7 - fuel filter, 8 - cap 9 - carburetor cover, 10 - cover gasket, 11 - solenoid valve, 16 - acceleration pump injector with ball valve

1,14 - obsady dysz głównych paliwa 1 i 2 przelotu, 2. 15 - dysze główne paliwa 1 i 2 przelotu, 3 - obsada dyszy paliwa biegu jałowego Il przelotu, 4.12 - pierścienie uszczelniające. 5,13 - dysze paliwa biegu jałowego, 6 - plywak, 7 - filtr paliwa, 8 - korek 9- pokrywa gaźnika, 10 - uszczelka pokrywy, 11 - zawór elektromagnetyczny, 16 - wtryskiwacz pompy przyspieszającej z zaworem kulkowym

The operation of the carburetor control system is limited to the periodic checking of the correctness of the throttle and tendon adjustment of the starter unit (discussed in chapter 2.1.5). It is recommended to lubricate the hinges, bearings and tendons during the inspection so that the system operates smoothly and without jams.

2.1.10 S-21 Maintenance

The operation of the suction pipe consists in periodic checking of the permeability of the holes, the drainage of liquid fuel and tightening: nuts fixing the suction-exhaust pipe. The air filters are operated by blowing the three paper filter elements out with compressed air, replacing them every 9000 km and adjusting the iris of the cold or heated air within the framework of the seasonal service: moving the handle A (Fig. 2.51) to position B (blue arrow) draws in the cold air, and in position C (red arrow) the heated air.

■ Operation of the lubrication system. Correct and timely maintenance has a crucial influence on the durability of the engine (reduction of friction and thus wear of cooperating parts). The operation of this system is limited to:

- periodic oil change,
- periodic replacement of the full flow oil filter (including oil change in the oil sump),
- checking the oil pressure while the engine is running,
- checking the tightness and patency of the crankcase ventilation systems and the functioning of the exhaust extraction valve (12, Figure 2.2).

The oil level in the oil sump is checked (the vehicle should be placed on a horizontal surface) with a dipstick when the engine is cold. The trace left by the oil must be between the 'P' lines. (maximum state) a ,,0". (minimum state). During refilling, care must be taken to ensure that the topping up grade (different grades must not be mixed) and that the maximum level is not exceeded, which results in increased resistance to crankshaft movement, combustion and leakage of excess oil.

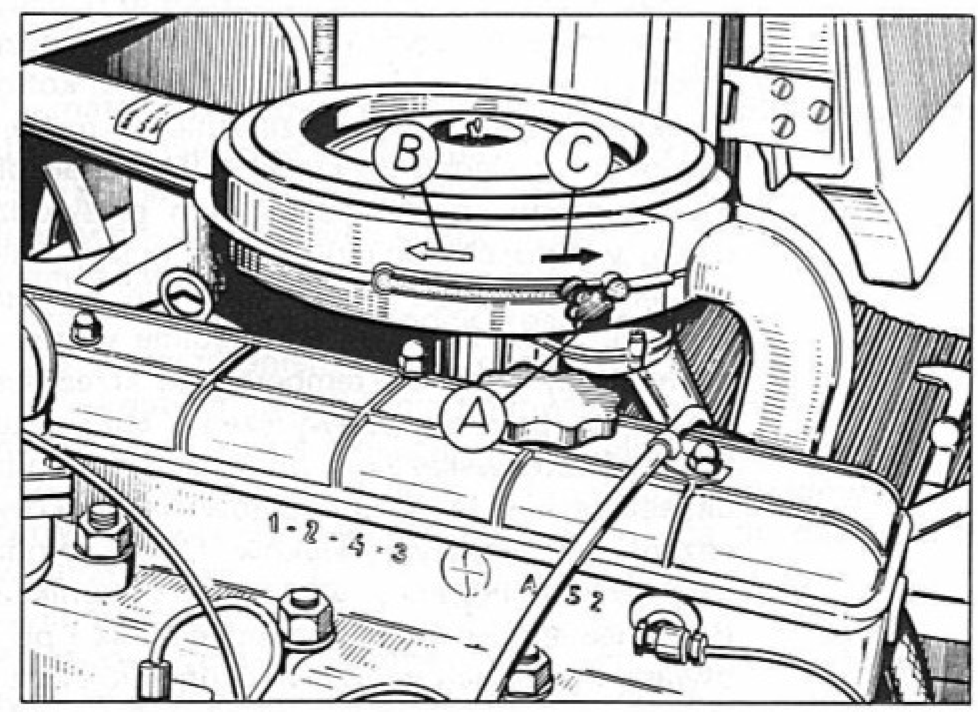
The oil change is carried out at the same time as the oil filter is changed. Used oil is drained from the oil sump when the engine is warmed up to normal operating temperature. If the oil change is related to a change of oil grade, it is recommended to wash the lubrication system with the same oil to be used in further operation. In this case, the system fills up with new oil to the minimum level on the bar gauge, starts the engine for 5...10 min, drains the dirty oil and pours the new oil to the maximum level.

The oil pressure shall be checked when the engine is warmed up by means of the pressure gauge on the instrument panel. If the indicator or sensor is suspected to be defective, check the oil pressure with a gauge. Excessive pressure may be caused by the use of excessive viscosity oil, by a defect in the piston valve of the oil pump (permanently closed) or by contamination of the filter, oil channels and oil lines. The causes of too low an oil pressure can be too little oil in the bowl (below the minimum level), contamination of the dragon and the oil suction lines, use of under-viscous oil, failure of the oil pump piston valve (permanently open), excessive wear of the pump or excessive play in the crankshaft and camshaft.

Sudden loss of oil pressure during vehicle operation can be caused by damage to the drive of the oil pump (mostly cut dowels (8, 11, Fig. 2.34), oil hoses or rubber hose (36, Fig. 2.2) of the closed engine crankcase ventilation system, or by melting down the crankshaft shells.

Verification of the tightness of the crankcase ventilation systems is carried out in order to ensure the cleanliness of the exhaust fumes and to limit oil leaks from the oil sump. Such leaks in the closed

system may occur in the case of a leaky connection between the rubber pipe (36, Fig. 2.2) and the pipe (37, Fig. 2.2), in the case of cracks in any of the pipes, possibly after the pipe (36) has slid off the vent (32, Fig. 2.2).



A - Iris handle,
B - cold air intake (blue arrow),
C- intake of heated air (red arrow)

A - uchwyt przysłony,
B - zasysanie zimnego powietrza (strzalka niebieska),
C- zasysanie podgrzanego powietrza (strzalka czerwona)

2.51. Figure: AIR FILTER - IRIS CONTROL

■ The operation of the cooling system involves the following steps:

- checking, replenishing and, if necessary, replacing the coolant,
- system leakage checking,
- checking the function of the thermostat,
- adjustment of the belt tension of the pump and fan drive, self-locking of the pump bearings in the cooling system,
- rinsing of the system and removal of boiler scale.

In the cooling system, regardless of the type of liquid used, its level should reach the MIN line marked on the wall of the equalisation tank (with a filled line connecting the tank with the radiator filler neck). Losses of coolant due to leaks in the cooling system must be topped up with the same coolant as the system. This is particularly important for special liquids with low solidification temperatures. Diluting them with water causes an increase in the freezing temperature (Table 2-19). Detailed instructions for handling these liquids are given by the manufacturers on the packaging and should be followed by the users. The cooling system is filled via the radiator filler neck or the equalising tank throat. After filling, start the engine and after venting the system (with the filler caps open) top up the liquid to the required level.

Chemical composition of the fluid		**Liquid density at 20°C, g/cm³**	**Freezing temperature, °C**	**Note**
Distilled water, % vol.	**Ethylene glycol, % vol.**			
50	50	1,068	-35	Borygo Liquid*
55 60 65 70 80	45 40 35 30 20	1,063 1,057 1,050 1,043 1,029	-29 -25 -19 -15 -10	Borygo liquid diluted with distilled water
* This Borygo liquid is sold by CPN stations. It contains 50% by volume of distilled water, 49% ethylene glycol and about 1% anticorrosive and antifoaming additives. FRITOM liquid can be used instead of Borygo liquid for engine cooling and cabin heating. These fluids cannot be mixed with each other, with ANTYFRYZ fluid, or with other fluids.				

2.19. Table: PROPERTIES OF THE DILUTED COOLING LIQUID WITH DISTILLED WATER

When filling with liquid, make sure not to pour cold liquid into an overheated engine. If necessary, wait until the temperature of the motor has dropped (leave the motor idle and pour a small amount of liquid over it so as not to cause thermal stress in the metal parts, which may cause micro-cracks, expand during further use and require troubleshooting.

The cooling liquid from the cooling system is drained off through the valves in the hull and the radiator (see Chap. 2.1.7) with the heater valve open. The detected leaks must be rectified as quickly and accurately as possible (depending on the leak location) by

- tighten the clamping brackets on the wire connectors,
- replacement of gaskets and seals in the cooling system,
- soldering of radiators or heaters.

The thermostat works well when there are such symptoms as: too long heating of the motor after starting it up or its quick overheating. After removing the thermostat, it is necessary to immerse it in a container of water and heat it, observing the temperature of the beginning and the complete opening of the valve on the thermometer. The correct temperature values are as follows:

- for the beginning of the opening 68...74°C,
- for total opening 78...83°C.

Replace the defective thermostat with a new one.

The belt tension (chap. 1.5) is adjusted by repositioning the alternator relative to the motor hull (Fig. 2.52). Excessive tension causes accelerated wear to the belt and bearings of the cooling pump. If the tension is too low, the belt slips and the cooling intensity is reduced (the motor heats up).

Overheating of the motor can also be caused:

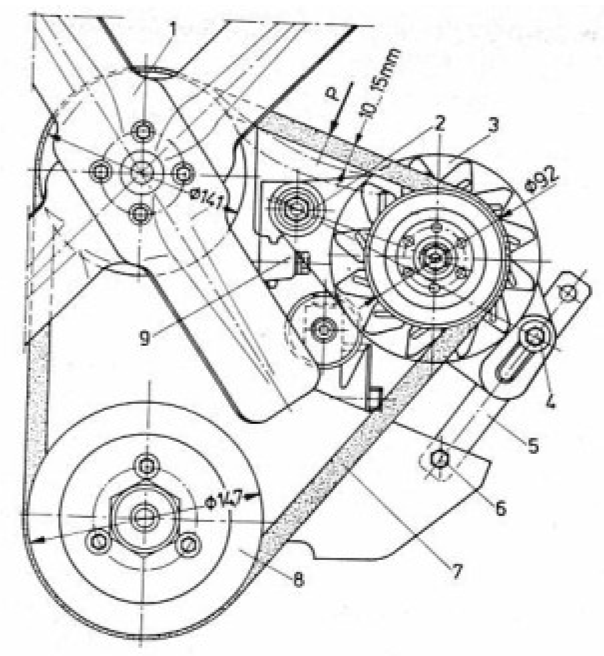
- contamination of the radiator with deposits,
- contamination of the external surfaces of the radiator,

- limescale deposits (mainly calcium and magnesium salts) on the internal walls of the cooling system.

Rinsing the cooler (to remove deposits) with a hot water jet from the bottom of the nozzle to the filler neck (opposite to the direction of the normal liquid circulation in the system) is most convenient after it has been removed from the vehicle.

Contamination with boiler scale is removed by a 10 % solution of caustic soda or a slightly weaker solution of hydrochloric acid heated to approximately 90°. The solution must be drained after 30 minutes and the condenser flushed three times). Contaminants on the external surfaces of the radiator are simply washed off with a jet of water from the water supply system and blown off with compressed air. This must be done from the motor side in the outward direction.

The cooling system ducts in the engine body and head shall be cleaned with lactic acid (60 g per 1 dm3 water) or hydrochloric acid (25...30 g per 1 dm3 water) lime scale. The treatment of engine ducts cleaning can be performed without disassembling the engine, but after removing the thermostat and disconnecting the radiator, in order to prevent its clogging with deposits removed from the system. In the case of a small amount of boiler stone, the connection system remains unchanged after the thermostat has been removed. Otherwise, after removing the thermostat and the radiator, connect the outlet port of the thermostat casing to the suction port of the cooling system pump with an additional (special) hose. After pouring the hydrochloric acid solution into the system, start the engine and leave it idling for approximately 30 minutes (the solution may boil), after which the system must be emptied and rinsed with running water. The lactic acid solution must be left in the engine for 1...3 hours. No water solution of caustic soda can be used to remove scale from the engine due to its destructive effect on the aluminium alloys of which they are made: e.g. head, pump body of the cooling system, thermostat casing.



2.52. Figure: TENSION ON THE V-BELT OF THE PUMP DRIVE AND THE FAN OF THE COOLING SYSTEM

1 - fan,
2 - axis,
3 - alternator,
4,6 - screws,
5 - bracket,
7 - V-belt.
8 - belt pulley

1 - wentylator,
2 - oś,
3 - alternator,
4,6 - śruby,
5 - wspornik,
7 - pasek klinowy.
8 - kolo pasowe

■ The maintenance of the exhaust system shall include: checking the integrity of the connections, checking the operation of the mixture heater, checking the condition of silencer and exhaust pipe hangers, and removing carbon from the exhaust pipe. Periodic checking of the tightness of the exhaust system is an important maintenance activity due to the toxic components of the exhaust gases which may enter the driver's compartment or the passenger compartment and the danger of fire.

A leak in the system is manifested by an increase in the noise level of the exhaust pipe. Removal of blow-throughs on the connections is done by tightening the fixing nuts or, additionally, by replacing the damaged gaskets. Leaks due to pipe or silencer breakage may be welded together (if the type of damage permits).

Overheating of the engine, manifested by a drop in power and interference in its operation, may indicate a malfunction of the automatic mixture heater, consisting in blurring of the throttle axis or damage to the bimetallic spring. In the first case, the exhaust pipe together with the heater must be repaired, in the second case, the spring must be replaced.

Damaged rubber hangers of the silencer and exhaust pipes can be replaced by new ones.

2.1.11 S-21 Repairs

Although the engine is complex and complex, it is characterized by high reliability and high mileage between repairs. The main symptoms of its malfunction are: difficult start-up, power drop, excessive smoke, increased fuel consumption, increased oil consumption and increased noise level. In one case it is enough to adjust the appropriate mechanisms, in another case it occurs after the engine must be sent for repair.

A list of typical symptoms and the most common operating conditions of the engine are given in Table 2-20; the table also contains information on how to remove the detected defects.

Repairs, which restore the engine's full technical efficiency, are divided into running repairs (NB), intermediate repairs (NS) and overhauls (NG). The purpose of NB and NS is to remedy abnormal engine failures. The task of NG is to bring the engine to a technical condition, which enables it to perform next, full, inter-repair runs. The engine shall undergo a major engine repair if at least one of the following operations is required to be carried out on the engine:

- grinding or replacement of cylinder liners with replacement of complete pistons,
- grinding the pivots or replacing the entire crankshaft and its bearings,
- replacement or repair of the hull with simultaneous repair of the entire engine to the extent resulting from operational wear and tear or emergency damage. The main repair (NG) may only be carried out by specialist repairers.

2.1.11 S-21 Repairs

Trouble	Reasons	Method of repair
1. Cold engine cannot be started	1.1. No fuel in the tank.	1.1 Fill the tank.
	1.2. Lack of fuel in the float chamber of the carburetor.	1.2 Fill the float chamber of the carburetor with the hand lever of the fuel pump.
	1.3. Tight or dirty fuel lines.	1.3 Tighten the couplings; blow out the hoses with compressed air.
	1.4. Fuel pump defective.	1.4 Replace damaged parts (diaphragm, valves, glass of settling tank); remove any leaks.
	1.5. Incorrect fuel level in the float chamber.	1.5 Adjust the fuel level. Check the float for leaks - replace damaged float. Check the tightness of the fuel inlet valve to the float chamber - leaking the valve has reached or has been replaced.
	1.6 Contaminated fuel nozzles of the carburettor starter.	1.6 Unscrew the nozzles and blow them off with compressed air.
	1.7. carburetor damper blockage.	1.7 Check the function and adjust the carburetor control mechanism.
	1.8 Engine "flooded" (fuel in suction line) due to incorrect operation of carburetor starting device.	1.8 Switch off the starter rod. Completely depressurise the accelerator pedal. Switch on the starter unit at intervals of several minutes.
	1.9. Leaky carburettor-suction connection (air intake outside the carburettor).	1.9 Tighten the carburettor retaining nuts; replace damaged seals.
	1.10. Battery disconnect device not switched on.	1.10. Switch on the battery disconnector.
	1.11. Battery discharged.	1.11. Replace or recharge the battery or, if necessary, start the engine with the crank handle by pushing or pulling the vehicle.
	1.12. Battery cable terminals corroded or loose.	1.12. Clean and secure the terminals.
	1.13. Damaged or not attached cable (red) from ignition switch to starter electromagnetic switch.	1.13. Replace damaged cable and fix it firmly.
	1.14. Starting device damaged.	1.14. Short circuit main starter clamps. Rotation of the rotor indicates damage to the solenoid switch. Replace defective Switch.
	1.15. High-voltage wires which are faultily connected, damp or damaged.	1.15. Humidly dry, replace damaged hoses and connect with suitable candles (in the order indicated on the motor head).
	1.16. Damaged: ignition distributor head or distributor finger (cracks, crushing).	1.16. Replace damaged parts
	1.17. Spark plugs damaged.	1.17. Remove spark plugs, clean and adjust electrode spacing. Check the spark plugs for visible damage: Before high voltage, fix the vassadiers to the ground and observe the distance between the electrodes after the starter has moved. No sparks or poor sparks qualify the candle for replacement.
	1.18. Ignition distributor capacitor defective.	1.18. Remove the ignition distributor head and finger. Switch on the starter, observe the distance between the contacts. If a high intensity spark occurs, the capacitor may be damaged. Replace defective capacitor.

2.20. Table: S-21 ENGINE TROUBLESHOOTING

2.1.11 S-21 Repairs

1. Cold engine cannot be started	1.19. Ignition coil defective, ignition distributor breaker defective or ignition switch defective.	1.19. Adjust the contact spacing the interrupter. Use the crank handle to move the interrupter contacts to a closed position. Move the end of the high voltage coil cable closer to ground at a distance of 5...7 mm. Dismantle the breaker contacts mechanically (e.g. with a screwdriver) by observing the spark jump at the end of the high voltage coil cable. If there is no spark, the interrupter or solenoid is damaged. Disconnect the ignition coil cable (black connected to the "22" coil terminal) and the capacitor cable from the interrupter and touch the ground with the common connector. A spark at the end of the high voltage coil cable indicates a fault in the interrupter. Replace defective interrupter. No spark formation indicates damage to the ignition coil or switch. Disconnect the cable from the "21" coil terminal, touch the end to ground. If there is a spark at the distance between the cable and ground, this indicates that the coil is damaged. Replace damaged unit. No twisting indicates damage to the ignition switch or to the connecting cables. Replace damaged Switch and leads.
	1.20. Ignition timing incorrect.	1.20. Adjust the ignition advance angle, check the correctness of the adjustment in the road test. Press the accelerator pedal rapidly when driving in direct gear at a speed of 55 km/h to 60 km/h. The appearance of detonation in the engine indicates accelerated ignition; no detonation - delayed ignition. Correct the ignition advance angle by turning the ignition distributor (in the direction of the distributor shaft rotation - ignition acceleration; in the opposite direction - deceleration) to obtain weak, disappearing detonations indicating correct ignition setting.
	1.21. Oil condensate in oil sump (low ambient temperatures).	1.21. Rotate the crankshaft with the crank handle (repeatedly). Start the engine with the clutch pedal depressed.
	1.22. Valve leakage; wear of pistons, rings and cylinders; seizing (securing) of piston rings; seizing of pistons, crankshaft bearings or camshaft.	1.22. Refer the engine to an ATS or repair shop for repair.
2. Hot engine cannot be started	2.1 Reasons as in points 1.1 to 1.7, 1.9 to 1.15 (not due to dampness) and 1.16 to 1.20.	2.1. method of repair according to points 1.1. to 1.7., 1.9. to 1.15. (no wires to be dried) and 1.16. to 1.20.
	2.2. Vapor lock in the power supply system (motor overheating).	2.2 Allow the engine to cool down. Fill the float chamber of the carburetor with the hand lever of the fuel pump. Start the engine with the accelerator pedal slightly depressed.
3. During startup, the motor tends to change the direction of rotation (reflection)	3.1 Too large an ignition advance angle.	3.1 Reduce the ignition advance angle and check that the adjustment is correct as per paragraph 1.20.
Silnik podczas rozruchu wykazuje tendencję do zmiany kierunku prędkości obrotowej (odbija)	3.2 Ignition distributor centrifugal regulator defective.	3.2 Remove the ignition distributor head. Rotate the finger of the distributor slightly. The finger should return to its original position when released. Failure to return indicates damage to the centrifugal controller. Replace the ignition distributor with a defective centrifugal controller.

4. The engine stops after starting.	4.1 Switch off the carburetor starter cable too early.	4.1 Turn on the carburetor starter. Restart the engine.
	4.2 Power supply faults as in points 1.1 to 1.4.	4.2 Method of repair according to points 1.1-1.4.
	4.3 Incorrect adjustment of the carburettor's idling device or contaminated idling fuel nozzles.	4.3 Adjust the engine idling speed or unscrew the idling fuel nozzles and purge with compressed air.
	4.4 Water in fuel.	4.4 Drain the supply system. Blow out the system with compressed air and fill it with clean fuel. Fuel contaminated with water after separation (water will fall to the bottom of the container) can be deposited and used for further operation
	4.5. contaminated dry air filter cartridge.	4.5 Replace contaminated cartridge.
	4.6. Electrical installation faults as in 1.12; 1.15. to 1.19. (not due to ignition switch faults).	4.6. Method of repair according to paragraphs 1.12; 1.15 to 1.19 (without verifying that the ignition switch is working correctly).
	4.7 Dirty silencer or exhaust pipe.	4.7 Dismantle, clean (see Chap. 2.1.10).
	4.8 Incorrect adjustment of valve lash.	4.8 Adjust the valve lashings (see Chap. 2.1.10).
	4.9. head gasket defective.	4.9 Drain the cooling fluid from the cooling system, replace defective gasket, replace oil in the lubrication system.
	4.10. Cams worn or excessive play of the ignition distributor shaft.	4.10. Replace the ignition distributor.
5. irregular engine idling	5.1 Power supply faults as in points 1.3; 1.5; 1.9; 4.1 (or not switched off for too long) 4.3; 4.4 or 4.5.	5.1 Method of repair according to points 1.3, 1.5, 1.9, 4.1, 4.3, 4.4 or 4.5
	5.2. electrical installation faults as in 1.11, 1.15, 1.16, 1.17 or 1.20.	5.2. Method of repair according to paragraphs 1.11, 1.15, 1.16, 1.17 or 1.20.
	5.3 Fuel with an incorrect octane number (too low).	5.3. correct the ignition preview angle by adjusting the octane selector plate (one graduation corresponds to a 2° change of the ignition preview angle or refill the container with an 86LO/B octane fuel.
	5.4 Damaged gasket in the suction pipe.	5.4 Replace damaged gasket.
	5.5 Dirty interrupter contacts, incorrect contact spacing or weakened moving contact spring.	5.5 Clean the contacts, adjust the distance. Replace moving contact with weakened (cracked) spring.
	5.6 Defective vacuum regulator	5.6 Remove the ignition distributor head and finger of the distributor. Rotate the interrupter plate around the vertical axis. In the event of a defective spring of the vacuum regulator, the plate does not return to its original position. Disconnect the vacuum hose from the regulator on the carburettor. Apply positive or negative pressure to the cooker. Lack of tightness indicates that the controller diaphragm is damaged. Replace the ignition distributor with a defective controller.
	5.7 Excessive clearance in the bearing of the mixture throttle shaft.	5.7 Replace the carburettor or have it repaired by an ASO.
	5.8. Ignition distributor faults as in paragraph 4.10.	5.8. Method of repair according to item 4.10.
	5.9 Excessive valve lashings in guideways; valve spring weakening or cracking; wear of camshafts.	5.9 Direct the engine for repair in the ASO or after the repair position.
6. irregular engine operation at medium and high speeds	6.1. Power supply faults as in 1.3, 1.4, 1.5 or 1.9.	6.1. Repair method according to 1.3, 1.4, 1.5 or 1.9.

	6.2. electrical installation faults as in points 1.17; 1.18; 1.19 (not due to a malfunction of the ignition (start) switch) or 1.20	6.2. Method of repair according to 1.17, 1.18, 1.19 (without checking the proper functioning of the ignition switch) or 1.20
	6.3 Contaminated carburettor fuel nozzles.	6.3 Partially disassemble the carburettor (see Chap. 2.1.10), clean the fuel nozzles with compressed air.
	6.4. Ignition distributor faults as in point 4.10.	6.4. Method of repair according to item 4.10.
	6.5. timing mechanism malfunctions as in point 5.9.	6.5 Procedure to be followed according to paragraph 5.9.
7. unexpected stopping of the engine	7.1. Power supply faults as in 1.1, 1.4, 2.2, 4.4 or 6.3.	7.1. method of repair according to 1.1;1.4; 2.2; 4.4 or 6.3.
	7.2. Electrical installation faults as in 1.16, 1.19 or 5.5 (breakage of moving contact spring).	7.2. Method of repair according to paragraph 1.16, 1.19 or 5.5.
	7.3 Piston, crankshaft or camshaft bearing seizure; crankshaft or crankshaft screw seizure.	7.3 Direct the engine for repair in the ASO or after the repair position.
8. the engine does not run at full power	8.1 Power supply faults as in points 1.4, 1.5, 1.9, 2.2, 4.5, 5.3 or 6.3.	8.1. method of repair according to points 1.4, 1.5, 1.9, 2.2, 4.5, 5.3 or 6.3.
	8.2 Incomplete opening of throttle Throttle valve Overflight limit.	8.2 Adjust the carburettor throttle control mechanism.
	8.3. electrical installation faults as in items 1.16 to 1.19 (not due to ignition switch faults); 1.20, 3.2, 5.5 or 5.6.	8.3. Method of repair according to paragraphs 1.16 to 1.19 (without verifying that the ignition switch is functioning correctly); 1.20, 3.2, 5.5 or 5.6.
	8.4 Leakage of valves.	8.4 Direct the engine for repair at the ATS or repair shop.
9. engine overheating	9.1 Slippage or breakage of the V-belt drive of the cooling system pump.	9.1 Adjust the belt tension (see Chap. 2.1.10). Replace defective V-belt.
	9.2 Too little coolant in the cooling system.	9.2 Make up to the required volume.
	9.3 Contaminated external surfaces of the radiator.	9.3 Clean (see Chap. 2.1.10).
	9.4 Contaminated cooling system (deposits or limescale).	9.4 Flush the cooling system (see Chap. 2.1.10).
	9.5. cooling system pump defective (leakage).	9.5 Replace the defective pump or have the ATS repaired.
	9.6. Thermostat defective.	9.6 Check the function of the thermostat (see Chap. 2.1.10). Replace defective thermostat.
	9.7. radiator damaged.	9.7 Replace damaged radiator.
	9.8. Coolant temperature sensor or indicator defective.	9.8 Replace defective components.
	9.9. fan blades damaged.	9.9 Replace the fan.
	9.10. Radiator blade fitted and pulled over.	9.10. Lower the cover.
	9.11. Too small an ignition advance angle.	9.11. Increase the ignition advance angle and check that the adjustment is correct as per paragraph 1.20.
	9.12. Defects as in point 1.17 or 3.2.	9.12. Repair method according to paragraph 1.17 or 3.2.
	9.13. No oil in the lubricating system or too low a level in the oil sump.	9.13. Check and refill the oil to the required level.
	9.14. Defect as in point 4.9.	9.14. Repair method as in item 4.9.
	9.15. Oil filter contaminated.	9.15. Change oil filter.

	9.16. Oil pump bypass valve defective.	9.16. Check the condition of the valve piston and spring; replace damaged parts.
	9.17. Engine overload (high engine speed at low forward speed).	9.17. Engage a gear which is suitable for the traffic conditions and slow down the engine speed.
	9.18. Burnt chamber contaminated by carbon.	9.18. Clean the combustion chambers (see Chap. 2.1.10).
	9.19. Too low a fuel mixture (activation of the starting device interrupts the sneezing phenomenon into the carburettor)	9.19. Partially dismantle the carburettor (see Chap. 2.1.10), blow out the fuel nozzles with compressed air, adjust the fuel level in the float chamber. Eliminate the uncontrolled influx of so-called "soft drinks". false air'. (without carburettor) as a result of e.g. damage to the gasket under the carburettor, deformation of the suction pipe's contact surface.
	9.20. Operation of the engine at high ambient temperatures.	9.20. Use shielding for fuel pump and fuel line pump-boat, replace higher heat capacity radiator (four-row) and four-vane fan with **six-vane fan** in cooling system (differential parts and components are produced and used in **tropical variant "T"** of engine or in 4C90 engine).
10 Engine overcooling (does not reach normal operating temperature)	10.1 Malfunctions of the cooling system as in paragraph 9.6 or 9.8.	10.1. Method of repair according to paragraph 9.6 or 9.8.
	10.2 Damaged radiator grille or broken diaphragm control cord.	10.2 Replace damaged parts.
	10.3 Operation of the engine at low ambient temperatures.	10.3. operate the engine with the radiator shutter closed (also with the air inlet grille curtain in during frosty periods) and with a coolant that does not freeze in the cooling system.
11. silent carburettor engine (exhaust gas flow into the suction line) *Silnik „kicha" w gaźnik (przedmuch spalin do przewodu ssącego)*	11.1. Power supply faults as in points 1.3 to 1.5 or 6.3.	11.1. Method of repair according to paragraphs 1.3. to 1.5. or 6.3.
	11.2. electrical installation faults as in paragraphs 1.16, 3.1 or 3.2.	11.2. Method of repair according to 1.16, 3.1 or 3.2.
	11.3 Too little clearance of the suction valves.	11.3 Adjust the clearances on the suction valves (see Chap. 2.1.10).
	11.4 Engine cooling (reasons as in points 10.1 to 10.3).	11.4 Method of repair according to items 10.1-10.3.
	11.5. Suction valve leaking.	11.5 Direct the engine for repair at an ATS or at a repair shop.
12. the engine fires into the silencer (afterburning the mixture in the exhaust system)	12.1. Too rich fuel mixture (too high level of fuel in the float chamber, used fuel nozzles, defect as in point 4.5)	12.1 Adjust the fuel level in the float chamber; replace worn nozzles. Clean or replace the air filter insert.
	12.2. Electrical installation faults as in paragraph 1.16: 1.17 or 9.11.	12.2. Method of repair according to paragraphs 1.16, 1.17 or 9.11.
	12.3 Too little clearance of exhaust valves.	12.3 Adjust the expiratory valve lashings (see Chap. 2.1.10).
	12.4 Exhaust valve leaking.	12.4 Direct the engine for repair at an ATS or at a repair shop.
	12.5. defect as in point 4.5.	12.5 Method of repair according to item 4.5.
13 Excessive fuel consumption	13.1 Power supply faults as in point 1.3 or point 4.5.	13.1 Method of repair according to 1.3 or 4.5.
	13.2 Incomplete shutdown of the carburetor starter.	13.2 Push the rod holder of the starter device into place.
	13.3 Leakage of the fuel supply.	13.3 Check the system, replace damaged parts, tighten joints.

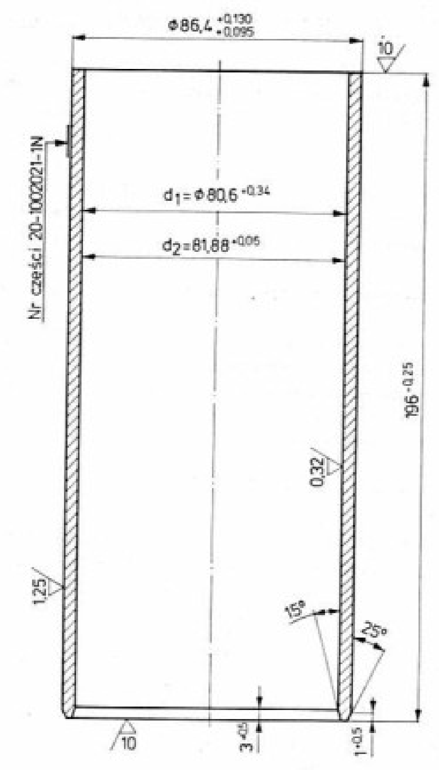
	13.4. Electrical installation faults as in points 1.17 to 1.19 (not due to faults in the ignition and interrupter switch); 3.2 or 9.11.	13.4. Method of repair according to paragraphs 1.17. to 1.19. (without verifying that the ignition and interrupter switches are working correctly); 3.2. or 9.11.
	13.5 Engine cooling (reasons as in points 10.1 to 10.3).	13.5 Method of repair according to items 10.1-10.3.
15 Exhaust gas coloring	15.1 Lubrication system faults as in paragraph 9.16 or 14.2 (**steel-blue exhaust**)	15.1 Method of repair according to item 9.16 or 14.2.
	15.2. Fuel supply system faults as in paragraph 12.1 or 13.2.	15.2 Method of repair according to paragraph 12.1 or 13.2.
	15.3. damaged head gasket (see point 4.9) or engine cooling (see points 10.1 to 10.3) (**dairy white exhaust**).	15.3 Method of repair according to items 4.9 and 10.1 to 10.3.
16 Engine noise and knocks	16.1. broken valve spring (sharp metallic knock at half the speed of the crankshaft).	16.1 Replace damaged valve spring.
	16.2 Excessive play of piston pins (metallic tapping clearly audible at idling speed).	16.2. to 16.7. Direct the engine for repair at the ATS or at the repair shop.
	16.3 Excessive clearance of pistons in cylinders (glues knocked when the crankshaft speed is increased rapidly, especially on the cold engine).	
	16.4 Excessive play in crankshaft bearings (audible knocks on the crankshaft at an increasing frequency which increases the crankshaft speed).	
	16.5. camshaft wear or excessive play in the camshaft bearings (camshaft knobs can be heard more clearly when the engine is warmed up).	
	16.6 Excessive play in the main crankshaft compartments (deaf, low-tone knobs, increasing with a sharp increase in engine speed).	
	16.7 Excessive play between the teeth of the camshaft drive wheels (high-tonnage noise).	

Hull repair. Cracks in hull walls up to 150 mm long, not reaching the edges and ending about 10 mm in front of stiffening ribs or penetration points, are repaired by electric welding: with Monel alloy electrodes (about 70% nickel and 30% copper), bimetallic electrodes (steel-copper) or carbon and low alloy steels, in coatings containing carbon, silicon and fluxes.

Smaller cracks can be removed by pinning with copper threaded studs of 4...5 mm diameter and single pores or holes by plugging them in with tapered threaded plugs.

Leaks in cooling or lubricating system ducts and cracks in walls up to 50 mm in length where the temperature does not exceed 180°C are also repaired by bonding with epoxy resins.

The tightness of the hull after repair shall be checked by a water test. The water pressure (0,3...0,4 MPa) generated in the cooling



2.53. Figure: CYLINDER SLEEVE (REPAIR)

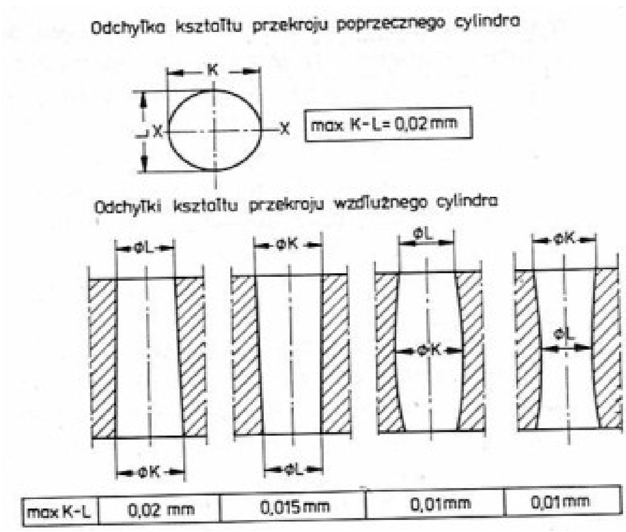
spaces of the hull shall be maintained for approximately 5 minutes to detect any leakage. Water at a temperature of approximately 60 °C shall be used for the test. Deflections of the upper surface of the hull shall be repaired by scraping

Hand-made, milled, sanded or ground on a surface grinder, in as thin a layer as possible. The acceptable flatness deviation is 0,05 mm and the roughness of the surface after treatment should not exceed 5 µm.

Cylinders with smooth running wear and tear are repaired through:

- boring the internal diameter to the next repair dimension (always the same for all cylinders) and then honing (recooling) the honing stone to achieve a high surface smoothness (roughness up to 0,32 µm) for the piston rings and pistons;
- insert cylinder repair sleeve (fig. 2.53). In this case, the hole in the hull should be drilled to the diameter of $86,4^{+0.035}$ mm. Once the sleeve has been inserted, its inner surface shall be machined as prescribed above, except that in either case the cylinders' axis shall be perpendicular to the crankshaft axis with a tolerance not exceeding 0,03 mm over 100 mm and the cylinder shape errors shall be as shown in Figure 2.54.

Worn tappet guides are opened to the next repair dimension, adjusted to the repair dimension of the tappet (see repair of the camshaft mechanism) with a play of 0.011...0.033 mm. After the last repair dimension has been used, or in other cases, the guides are repaired by bushing. Then enlarge the hole to $29,^{+0.033}$ mm and press in the cast iron sleeve (outside diameter $29^{+0,09}_{+0,05}$ mm, length 42 mm), which is drilled to the required repair dimension.



2.54. Figure: CYLINDER SHAPE ERRORS ALLOWED

In both cases, this must be achieved:

- roughness of smoothing up to 0,63 µm,
- perpendicularity of the guide axis to the camshaft axis with a deviation of up to 0,1 mm over a length of 100 mm,
- hole shape errors up to 0,015 mm.

The **repair of the main bearings of the crankshaft** is based on the replacement of bushings, which are selected depending on the repair dimension of the main pivots with a clearance of 0,012...0,057 mm (see Table 2-21).

Repair of camshaft bearings consists in replacement of bearing sleeves, in which holes are cut to dimensions appropriate to the repair dimensions of camshaft pivots (see Table 2-22), keeping the clearance within the limits:

- bearing 1 and 2 0.025...0.079 mm,
- bearing 3 and 4 0,025...0,076 mm.

2.1.11 S-21 Repairs

During machining, a distance of 118 ± 0,25 mm must be maintained between the main bearing axes of the crankshaft and camshaft bearings and the parallelism of these axes must be maintained to within 0,04 mm throughout their length. The permissible tolerance of the concentricity of the holes in the camshaft bearing sleeves is 0,4 mm.

Subsize of the pan	Diameter of main pin, mm
0,05 0,25 0,30 0,50 0,75 1,00 1,25	63,95 63,75 63,70 63,50 63,25 63,00 62,75
Tolerance of execution	0...-0,013

2.21. Table: SELECTION OF BUSHINGS FOR REPAIR DIMENSIONS OF CRANKSHAFT MAIN PIVOTS

Subdimension	Inner diameter of the sleeve, mm			
	I	II	III	IV
0,20 0,40 0,60 0,80	51,80 51,60 51,40 51,20	50,80 50,60 50,40 50,20	49,80 49,60 49,40 49,20	47,80 47,60 47,40 47,20
Tolerance of execution				

2.22. Table: REPAIR DIMENSIONS OF CAMSHAFT BEARING SLEEVES

Repair of the head. The head is repaired in the same way as the hull. However, given that it is made of a different material (aluminium alloy), cracked walls are arc-welded in an inert gas shield using electrodes of a material similar to AK 52 alloy and fluxes that strongly reduce oxides. After the repair, a leak test shall be carried out in accordance with the same rules as for the engine hull. Heads with cracks passing through valve seats, combustion chambers, inlet and exhaust ducts and cracks in the engine hull adhesion plane shall not be repaired. The swivelled lower surface of the head is repaired through:

- running in with an abrasive paste on the disc;
- milling of the material layer up to 0,3 mm (larger cavities cause excessive increase of the compression ratio); the permissible tolerance of flatness is 0,05 mm and the roughness of the surface after machining should not exceed 5 µm.

Valve guides are repaired by reaming to one of three repair dimensions (diameter $9{,}2^{+0.022}$ mm, $9{,}4^{+0.022}$ mm or $9{,}6^{+0.022}$ mm), corresponding to the diameters of repair valve handles, or by replacing them, which consists in squeezing out worn out guide rails, reaming a hole in the head to one of three consecutive oversizes (16.25); 16.50; 16.75 with a tolerance of +0.018 mm), by pressing in the repair guide and reaming its inside hole to a nominal size of $9^{+0{,}022}$ mm. Errors in the shape of

the guideway aperture after reaming shall not exceed 0,007 mm and the surface roughness shall not exceed 0,63 µm.

Every time you change the guide, grind the seats and laze the valves to maintain the required tightness and concentricity.

Valve seats are repaired by grinding or replacing the flap. The purpose of the abutment grinding is to restore the original shape of the abutment. After this treatment, the width of the flap shall be 1,5 ± 0,2 mm and its largest external diameter shall be 39,3 mm for the suction valve seat and 32,3 mm for the exhaust valve seat. If these dimensions cannot be obtained, three disks with apex angles of 120°, 90° and 60° shall be sanded successively on the adjacent surface. The permissible deviation of the co-axiality of the flap with the guide is 0,03 mm and is achieved by using the remote control discs in the valve guide (hence the need to replace or repair the guides before repairing the valve seats).

Excessively worn or damaged (cracked, crushed, burned) sockets shall be replaced by repair sockets of external diameters: $44{,}25^{+0{,}161}_{+0{,}136}$ mm or $44{,}50^{+0{,}161}_{+0{,}136}$ mm - for suction valve seats and $41{,}25^{+0{,}151}_{+0{,}126}$ mm or $41{,}50^{+0{,}151}_{+0{,}126}$ mm - for exhaust valve seats. The holes in the head are of the same nominal size, but with a deviation of +0,039 mm, and the valve seats are pushed together when the head is heated to a temperature of no more than 200°C. The holes in the head are made in the same way as the holes in the head. The adhesion of the seats to be replaced is polished and the valves arrive for a precise tightness.

Repair of crankshaft piston engines

■ Pistons that are worn or destroyed (burned bottoms, crushed, seized, cracked, etc.) are replaced by repair pistons. Complete pistons (with bolts and circlips) are produced for spare parts in twelve oversizes: 82.00; 82.08; 82.12; 82.24; 82.36; 82.50; 82.58; 82.62; 82.80; 83.00; 83.25; 83.50 mm with an outside diameter tolerance of $^{+0{,}036}_{+0{,}024}$ mm. Please note that all pistons in the engine must be of the same size, fit in cylinders with a clearance of 0.012...0.036 mm, be selected by weight to an accuracy of ± 2 g and be installed according to the rules in section 2.1.3.

Pistons with slight clogging or oversized hub openings (pin-piston play approx. 0.1 mm) can be repaired. In the first case, the repair involves cleaning and smoothing the external surface with a file and a fine grinding wheel (abrasive paper), and in the second case, reaming the holes for the oversized piston pin. The permissible deviation of the shape of the holes (conicity and circularity) shall not exceed 0,004 mm, the deviation of the perpendicularity of the hole axis to the piston axis shall not exceed 0,05 mm over a length of 100 mm and the surface roughness shall not exceed 0,63 µm.

■ Piston rings are replaced when damaged or when wear of the cylinder smoothing and outer diameter of the ring results in a larger gap in the ring lock than 0,45 mm and the degree of wear of the calipers and piston does not qualify for repair. Spare parts are produced sets of oversize rings, which are associated with the pistons in the manner specified in Table 2-23, keeping the clearance in the grooves of the piston within the limits:

- 0,060...0,092 mm - upper sealing ring,

- 0,050...0,082 mm - bottom sealing ring,
- 0,035...0,067 mm - scraper ring.

If, during the verification of the pistons to be repaired, the rings in the grooves have a lateral play of approx. 0,15 mm, the entire piston is replaced.

■ Worn or broken piston rods are replaced with new ones. Spare parts are manufactured with oversize bolts, marked on the inner surface with the following colors:

- black for diameter $22{,}08_{-0.005}$ mm,
- dark blue for diameters from $22{,}12_{-0.005}$ mm,
- brown for a diameter of $22{,}20_{-0{,}005}$ mm.

The permitted tapering and ovalisation of the outer surface of the pin must not exceed 0,0025 mm and the difference in wall thickness must not exceed 0,6 mm.

■ Cranks with clearly deformed shafts or other damage are replaced by new ones. Damage caused by sealing or welding may not be repaired. The crankshaft is repaired by straightening on presses or special instruments with a slightly deformed shaft, which after this operation allows the axis of the holes in the head and the head to be parallel to each other to an accuracy of 0,4 mm over a length of 100 mm. Replace the worn bushing on the crankshaft head with a new one. In this case, the hole in the head should be re-drilled to the size of a repair sleeve, keeping the distance of its axis from the hole axis in the head 202 ± 0,05 mm.

The pressed sleeve (see section 2.1.3) is either reamed or bordered to a dimension that allows clearance in connection with the pin to be achieved within 0.0045...0.0095 mm. The dimensional deviations of the crankshaft after repair should not exceed:

- the twistability of the head and Iba 0,05 mm shaft over a length of 100 mm,
- deviation of the perpendicularity of the face of the head or ba from the axis of the holes of 0,1 mm for a length of 100 mm,
- ovalidity and conicity of crank head and crank head holes 0,01 mm,
- distance between the axis of the head hole and the crankshaft head: ± 0,1 mm.

The surface roughness after machining should not exceed 0.63 µm, and errors in the shape of the hole (conicity, ovalisation) should not deviate by 0.005 mm.

Ring oversize	Outer diameter of the ring, mm	Piston diameter, mm
0,24 0,37 0,62 0,92 1,12 1,37 1,62	82,12 82,25 82,50 82,80 83,00 83,25 83,50	82,00-82,08-82,12 82,24-82,36 82,50-82,58 82,62-82,80 83,00 83,25 83,50
Luz na zamku	0,2...0,45	

2.23. Table: SELECTION OF RINGS FOR PISTONS REPAIR

■ Replace worn out crank shells with new ones. For spare parts undersize panes are produced in sets of 8 pcs. each. They should be selected depending on the repair dimension of the crankpin as per table 2-24.

Subsize of the pan	Diameter of crankpin, mm
0,05 0,25 0,30 0,50 0,75 1,00 1,25	51,45 51,25 51,20 51,00 50,75 50,50 50,25
Tolerance of execution	-0,01...0

2.24. Table: SELECTION OF BUSHINGS FOR REPAIR DIMENSIONS OF CRANKPIN PINS OF CRANKSHAFT

■ The crankshaft shall be replaced in the event of bending, twisting (more than 0°10') and pits and chipping which cannot be removed during the repair process. Crack detection is recommended on a magnetic or ultrasonic defectoscope, as visual inspection is in many cases not reliable. Most often, shaft repair consists in straightening and grinding worn out main and crankpin pins for the next repair dimension. The shaft shall be straightened and the main pivots, second and third in relation to the outer pivots, beat more than 0,03 mm (wear of the pivots shall be excluded during the test). If the journal bearing clearances exceed 0,15 mm and the shape errors are greater than 0,015 mm, the shaft shall be repaired by grinding the pivots and replacing the bushes with repair bushes, which shall be selected in accordance with Table 2-21 (installation clearance within 0,012...0,057 mm) and Table 2-24 (installation clearance within 0,025..060 mm). Main and crankpin grinding is usually carried out on the same repair dimensions. During this operation, special attention must be paid to maintaining the correct crankpin fillet radii ($2{,}5_{-0{,}8}$ mm for the main pivots and $2{,}0_{-0{,}8}$ mm for the crankpins) so as not to cause undercuts (notches), which are stress concentration points causing fatigue shaft fractures. If subsequent repairs achieve the last repair dimension, the shaft may be regenerated. The most commonly used method is spraying metallization (the applied layer of metal is within the limits of 0.75...2.0 mm), although repairs by welding and chromium plating are applied. After these operations, the pivots are polished to the nominal size. The minimum

roughness of the journal surface shall be 0,16 µm. The dimensional deviations of the crankshafts after repair shall be within the following limits:

- oval or playability of main and crankpin up to 0,015 mm,
- the conicity of the main and crankpin up to 0,01 mm over a length of 100 mm, - the parallelism of the forming crankpin surfaces to the shaft axis of 0,01...0,02 mm over a length of 100 mm,
- the radial runout of the centre crankshaft journal, supported by the outer pivots, shall not exceed 0,03 mm.
- the runout of adjacent main pivots shall not exceed 0,02 mm and for other main pivots 0,03 mm,
- the runout of the camshaft gear pin shall not exceed 0,01 mm,
- the axial runout of the flywheel attachment flange shall not exceed 0,01 mm,
- the concavity of the front surface of the flange shall not exceed 0,1 mm. Each repaired shaft is also recommended to be dynamically balanced to an accuracy of 0.002 N·m (at each end).

Worn bearing rings of the shaft thrust bearing are replaced with new ones or regenerated by pouring the rear ring with a white bearing alloy onto one of the recommended repair thicknesses: $2.65^{+0.05}$ mm or $2.85^{+0.05}$ mm.

■ The flywheel with a damaged or worn toothed ring is repaired by replacing the ring, which is shrunk when heated to 180°C. The unevenly worn wheel surface on the clutch disc is repaired by grinding. The flatness deviation after repair shall not exceed 0,05 mm, the axial runout of the mounting flange shall not exceed 0,08 mm within a radius of 140 mm and the surface roughness shall not exceed 0,63 µm.

Repair of the timing mechanism

Subdimension	**Diameter of kingpins, mm**			
	I	**II**	**III**	**IV**
0,20 0,40 0,60 0,80	51,80 51,60 51,40 51,20	50,80 50,60 50,40 50,20	49,80 49,60 49,40 49,20	47,80 47,60 47,40 47,20
Tolerance of execution	-0,019...0		-0,016...0	

2.25. Table: REPAIR DIMENSIONS OF CAMSHAFT BEARING PIVOTS

■ If the bearing pivots are worn, the camshaft must be repaired by grinding them to the next repair dimensions specified in Table 2-25; the permissible shape errors after machining (ovalisation, tapered shape) of the pivots must not exceed 0.01 mm, the bearing pivot beating! The length of the groove should not exceed 0.025 mm, the concentricity of the camshaft journal to the camshaft pivots should not exceed 0.01 mm, and the offset of the longitudinal plane of symmetry of the groove shoulder groove to the axis of the shaft should not exceed ± 0.075 mm, twisting of the

groove's longitudinal plane of symmetry with respect to the shaft axis up to 0.04 mm (on the groove's length), deviation of angles between the planes of symmetry of cams and the plane of symmetry of the groove up to ± 30', and roughness of the surface of pivots 0.32 µm. After each grinding of the pivots, a deepening of the oil grooves in the first pivot to the nominal dimension is required. Once the final repair dimension has been reached, it can be achieved by welding (material layer up to 2 mm), chromium plating (layer up to 0.2 mm) or hard nickel plating (layer up to 0.6 mm) to restore the nominal dimension of the pivots. These methods can also be used to regenerate the worn eccentric drive of the fuel pump and cams.

■ Replace worn or damaged tappets with new ones. Spare parts are produced with oversize tappets marked with different colours (Table 2-26), which are associated with guides while maintaining clearance within the limits of 0.011...0.033 mm. Any repair of the tappets is limited to chromium plating (up to 0.2 mm) and grinding of the working surfaces.

■ Worn bearing sleeves of the valve levers are replaced with new ones and the countersink is replaced to the nominal size, maintaining a roughness of 0.63 µm. After pressing in the sleeve, make a coaxial oil hole in the sleeve with the hole in the crane.

Color	Pusher diameter, mm
Black	25,02
Green	25,20
Yellow	25,50
Red	25,80
Tolerance of execution	-0,022...+0,011

2.26. Table: REPAIR DIMENSIONS OF TAPPETS

Color of the dimension designation	Handle diameter, mm	
	intake valve	exhaust valve
White	9,2	9,2
Yellow	9,4	9,4
Green	9,6	9,6
Tolerancja wykonania	-0,045...-0,030	-0,065...-0,050

2.27. Table: REPAIR DIMENSIONS OF VALVE STEMS

■ Valves are repaired by straightening, grinding or chromium plating handles and grinding mushroom sticks. The tolerance to straightness and shank run-out after repair shall not exceed 0,015 mm and the tolerance to shape errors (cylindrical and circular) shall not exceed 0,01 mm. The tolerance of the perpendicularity of the valve stem face to the cylindrical surface shall not exceed 0,03 mm over the handle length. The sanding tolerance of the valve stem surface is 0.03 mm. The permissible dimensional deviations of the angle of the flap shall be within ± 20'. The final adjustment of the valve to the seat consists in their mutual lapping in order to obtain the required tightness (air test at a pressure of 0.5 MPa). If, as a result of the subsequent grinding, the height of the cylindrical part of the valve block drops to 0.8 mm, the valve must be replaced with a new one. Valves with oversize handles are manufactured for spare parts (Table 2-27). After the valve or seat

has been repaired by grinding, the mounting height (distance between the lower spring seat in the head and the bearing surface of the valve lock bowl) must be checked before fitting the valve spring. The deviation from $43^{+0,5}_{-0,2}$ mm must be compensated for by a washer of sufficient thickness, which must be attached to the lower spring seat of the head.

■ Replace the camshaft sprockets with worn-out teeth or mechanical damage in pairs.

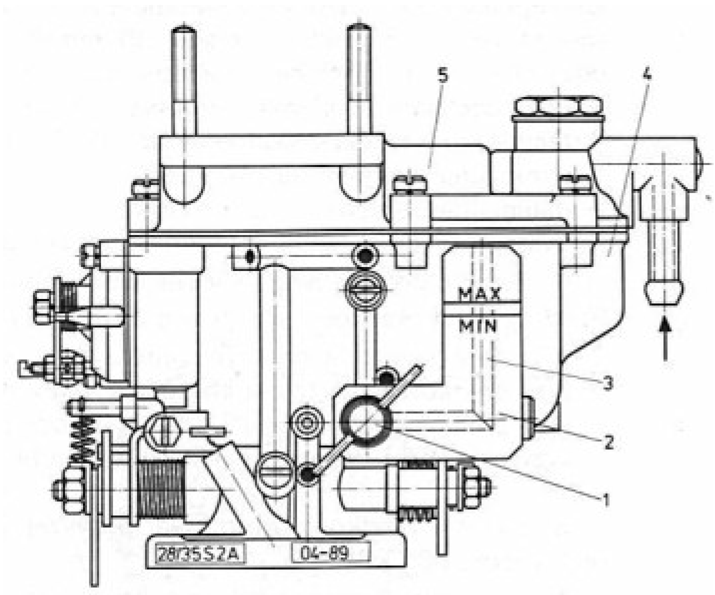
Other parts of the camshaft system are replaced with worn or damaged camshafts.

Repair of engine accessories

■ Repair of the fuel pump shall consist of replacement of worn or damaged parts, possibly by grinding the flange face (if the tolerance of parallelism exceeds 0.1 mm). After the pump has been repaired, its tightness, volumetric flow rate and suction and discharge pressure are checked at a special stand (see section 2.1.5). If the required parameters are not achieved, the entire pump is replaced with a new one.

■ Repair of a broken fuel tank consists in removing leaks by soldering (hard solder) or welding (in case of major damage). Before these operations, the tank must be emptied and rinsed with a heated, 10% aqueous solution of caustic soda (to remove petrol vapour). Then, fill the interior with approx. 52 dm^3 of water and turn the tank upside down for repair. After this, the airtightness of the container shall be checked at a pressure of 39 kPa.

■ Repair of 28/35S2A1 or 28/35S2B1 carburettors For replacement parts, repair kits are manufactured to allow for repairs to be carried out within the limits of the technical condition of the carburettor. After the repair, the level of fuel in the float chamber should be checked with a measuring device (Fig. 2.55), and with the use of special control and measurement equipment the operation of individual devices should be checked.



2.55. Figure: INSTRUMENT FOR CHECKING THE LEVEL OF FUEL IN THE FLOAT CHAMBER OF CARBURETOR 28/35 S2A1 OR 28/35 S2B1

1 - fixing screw, 2 - scaled up body of the device, 3 - pipe, 4 - float chamber, 5 - cover

1 - śruba mocująca, 2 - wyskalowany korpus przyrządu, 3 - rurka, 4 - komora pływakowa, 5 - pokrywa

■ Replace the oil pump gear wheels with worn (radial clearance greater than 0,062 mm) or damaged gear wheels. If the axial clearance of the wheels is exceeded by more than 0,275 mm, the cover or body shall be ground to restore a nominal clearance of 0,175 mm. Replace the remaining worn or damaged oil pump parts with new ones. The repaired oil pump shall be checked at a special stand. Its capacity shall be 1 dm^3 at 725 rpm, the discharge pressure 0,4 MPa and the bypass valve shall open at 0,55 MPa.

■ Replace worn or damaged parts of the cooling system pump with new ones. If necessary, small cracks in the pump can be repaired by bonding with epoxy resins, and the rotor shaft can be regenerated by chromium plating or metallisation and grinding to nominal size.

After repair, the pump should be assembled in such a way that the clearance between the rotor and the front of the casing is $0{,}5^{+,05}$ mm and the clearance between the blades and the wall is 0,5...1 mm. The pressure difference in the inlet and outlet lines should be within the limits of 0,08...0,12 MPa. . The radiator is replaced by a new one if the core is damaged. Small damages of tanks or pipes (available from the outside) are repaired by soldering. In exceptional cases, 10% of the total number of pipes may be excluded from circulation (blanking).

■ The curved fan blades are straightened back to their original shape, after which the eccentricity of the blade ends (permitted deviation up to 1 mm) and the axial run-out (tolerance up to 0,5 mm) are checked. The fan shall be statically balanced prior to installation.

■ In case of damage or blurring of the axle, the mixture heater throttle is replaced with a new one. For this purpose, openings in the walls of the exhaust pipe shall be drilled to $10^{+0.03}$ mm and the stainless steel or bronze repair sleeves with an outside diameter of $10^{+0{,}085}_{+0{,}055}$ mm shall be pressed into them. After assembly, the damper blade should rotate freely.

Other parts of the engine and its accessories that are worn or damaged shall be replaced as part of the repair.

A new engine or after a major repair (completed with the clutch and gearbox) is pre-laid in order to check the correct assembly, performance and pre-fitting of the cooperating parts and components. Running shall be carried out at a special stand within 35 minutes. The following operating parameters shall be maintained in an unladen engine:

- crankshaft speed 1000...1200 rpm,
- coolant temperature 75...85°C,
- minimum oil temperature 50°C,
- a minimum oil pressure of 196 kPa.

Upon initial arrival, the engine shall meet the following conditions.

(1) The idle speed shall be about 800 rpm. The motor must run evenly at this speed.

(2) The oil pressure of the heated engine (80 ± 5 °C) shall be:

- at idling speed of at least 78,0 kPa,
- at 1000...1100 rpm minimum 176,0 kPa,

- at a speed of 1800 ...2000 rpm within the range of 245 ... 372 kPa,
- in the speed range above 2000 rpm shall not exceed 539 KPA.

(3) The vacuum in the engine suction line shall be 60,0...66,6 kPa when the engine is idling.

(4) The engine shall be operated without distinctly different sounds. The following are not permitted: knocks of pistons, piston pins, main and crankshaft bearings, knocks or excessive noise on the camshaft gears, oil pumps, rotor and bearing pumps of the cooling system and different knocks of valves and pushers.

(5) The engine, when heated to 80 ± 5 °C, shall not drop coolant, oil or fuel within 15 minutes.

(6) The maximum power output of the engine at 2200 rpm shall not be less than 30,2 kW.

(7) The specific fuel consumption at the same crankshaft speed shall not exceed 10% of the specific fuel consumption (Figure 2.4).

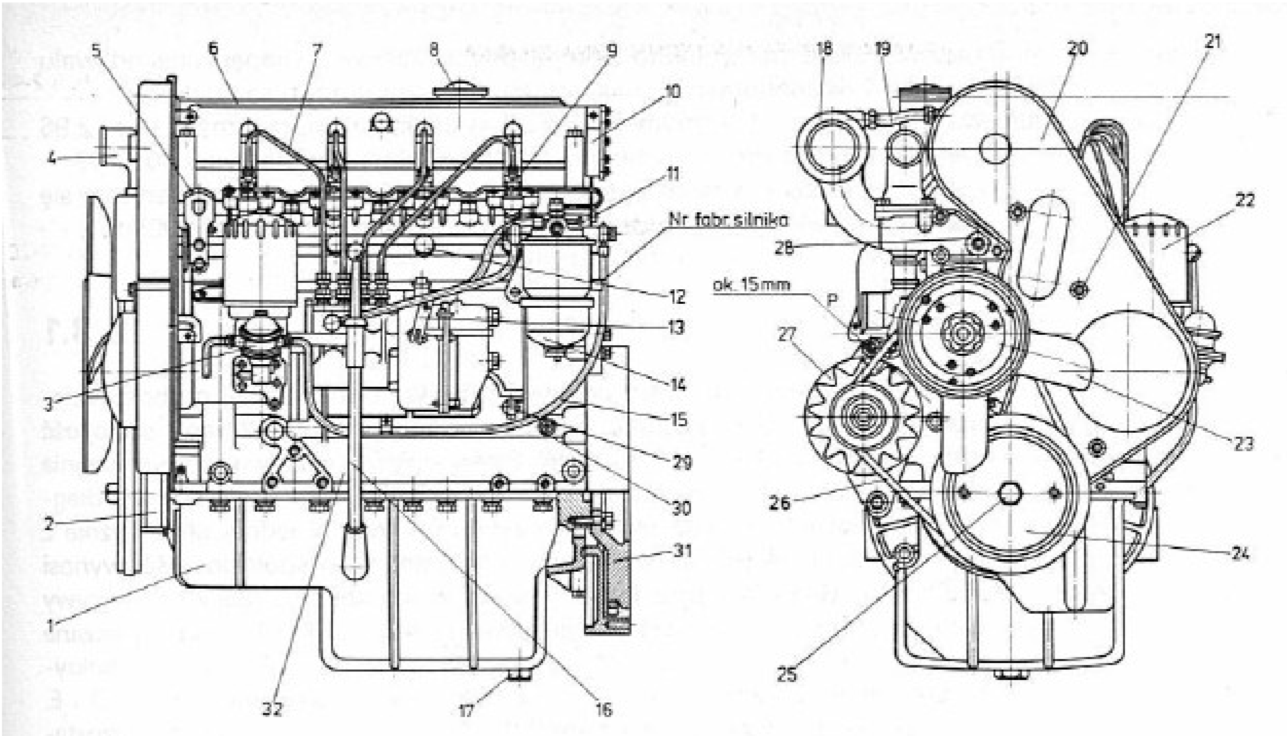
(8) The compression pressure shall be 0,98...1,078 MPa. The engine shall continue to run-in after installation in the vehicle and shall cover the first 1500 ± 200 km. It shall not be due during this period:

- start driving and increase the engine speed before heating it up for 1...5 minutes (depending on the ambient temperature),
- accelerate rapidly (increase crankshaft speed),
- overload the engine, i.e. drive at low speeds at high throttle openings,
- allow the engine to overheat (temperature increase in the cooling system above 90°C).

2.2 CB ENGINE (todo)

2.3 4C90 ENGINE

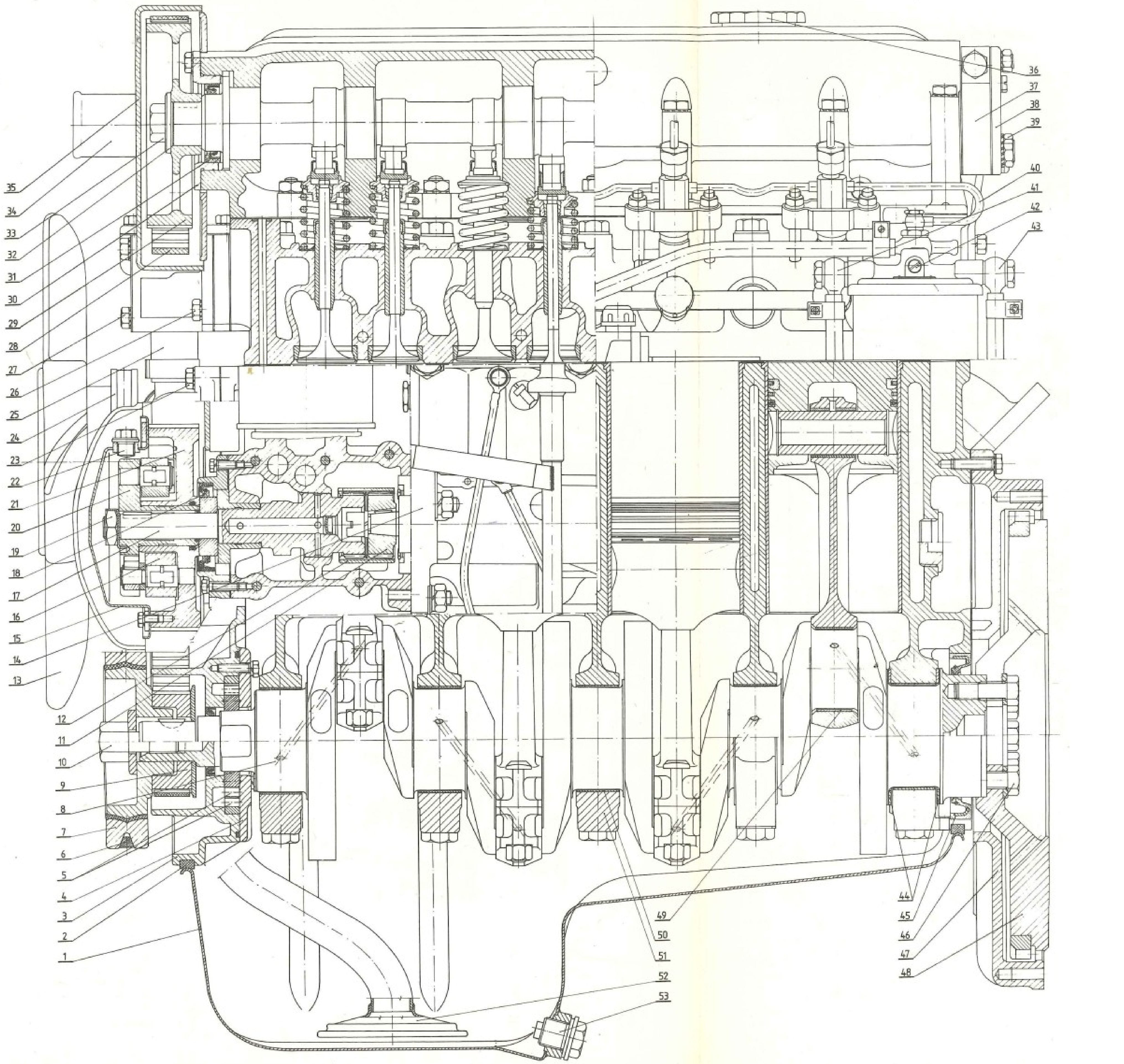
The 4C90 four-stroke diesel engine with intermediate injection into the swirl chamber has the technical characteristics given in Table 2.46. The external view of the engine and its accessories is shown in Figure 2.94. The dimensions of the engine are: length 699 mm, width 535 mm, height 734 mm. On the left side of the engine, looking in the direction of travel, there are: supply pump, injection pump, injectors, fuel filter, oil filter, oil level gauge, pre-injection angle adjuster, oil pressure sensor and liquid drain faucet from the cooling system; on the right side there are: alternator, starter, suction and exhaust pipes and oil filler.



2.94 Figure: 4C90 ENGINE - EXTERNAL VIEW

1 - oil sump, 2 - toothed belt drive of injection pump, 3 - supply pump, 4 - cooling liquid outlet, 5 - handle. 6 - cap of head cap. 7 - high pressure hose, 8 - oil filler cap. 9 - injector. 10 - vacuum pump. 11 - overflow line. 12 - Blow plug, 13 - control lever for injection pump. 14 - fuel filter. 15 - fuel line, 16 - oil level dipstick. 17 - oil drain plug. 18 - suction line, 19 - engine ventilation line, 20 - drive cover for injection pump and camshaft, 21, 25 - screws 22 - oil filter, 23 - fan. 24 - belt drive wheel for cooling system and alternator pumps, 26 - belt drive for cooling system and alternator. 27 - alternator, 28 - temperature sensor for coolant. 29 - oil pressure sensor, 30 - coolant drain tap from the engine hull, 31 - flywheel

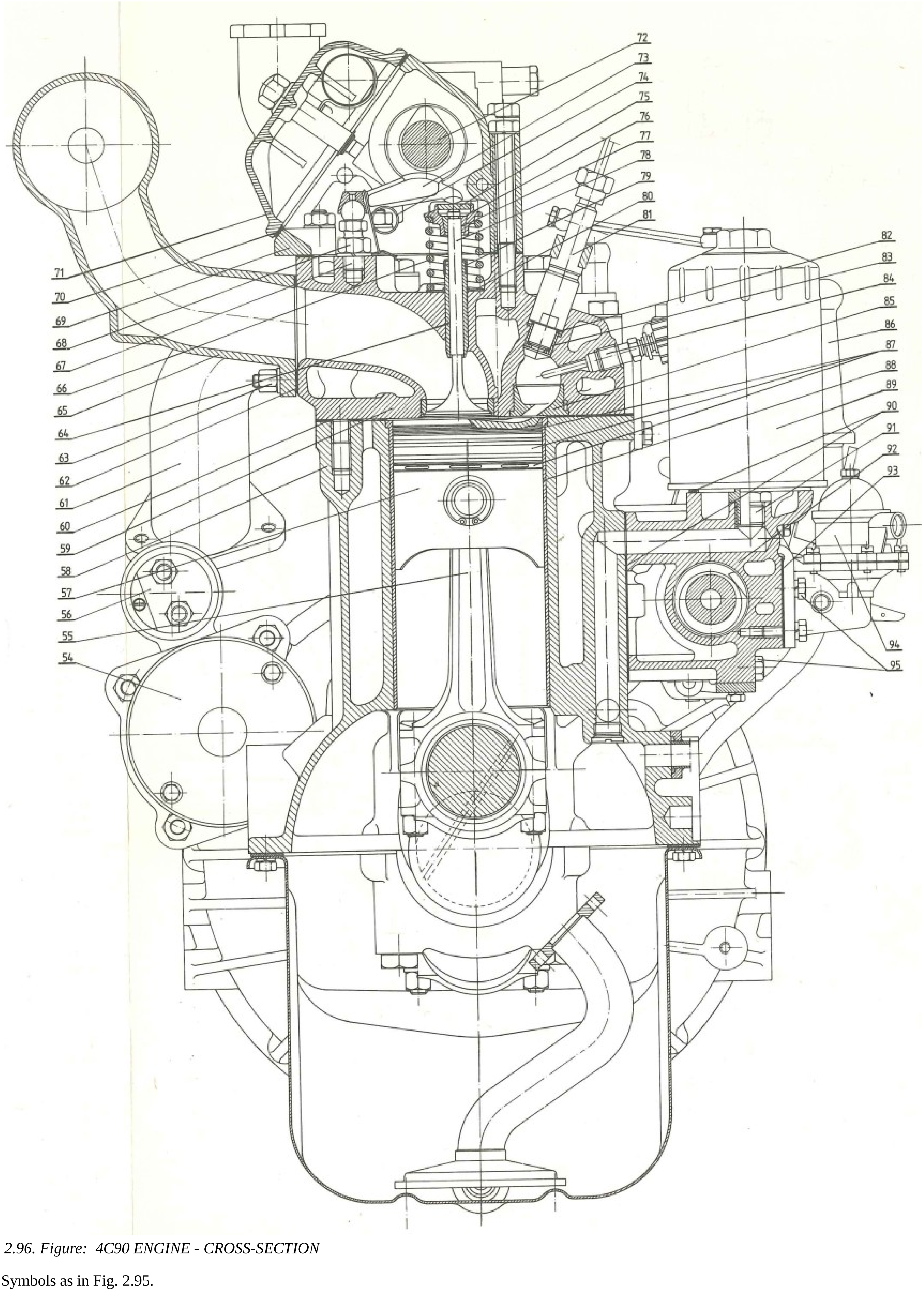
1 - miska olejowa, 2 - pas zębaty napędu pompy wtryskowej, 3 - pompa zasilająca, 4 - króciec wylotowy cieczy chlodzącej, 5 - uchwyt. 6 - pokrywa nasady głowicy. 7 - przewód wysokiego ciśnienia, 8 - korek wlewu oleju. 9 - wtryskiwacz. 10 - pompa podciśnieniowa. 11 - przewód przelewowy. 12 - Świeca zarowa, 13 - dźwignia sterowania pompa wtryskową. 14 - filtr paliwa. 15 - przewód paliwowy, 16 - miarka poziomu oleju. 17 - korek spustowy oleju. 18 - przewód ssący, 19 - przewód przewietrzania silnika, 20 - pokrywa napędu pompy wtryskowej i mechanizmu rozrządu, 21, 25 - śruby 22 - filtr oleju, 23 - wentylator. 24 - kolo pasowe napędu pompy układu chłodzenia i alternatora, 26 - pasek klinowy. 27 - alternator, 28 - czujnik temperatury cieczy chłodzącej. 29 - czujnik ciśnienia oleju, 30 - kranik spustu cieczy chłodzącej z kadłuba silnika, 31 - koło zamachowe



2.95. Figure: 4C90 ENGINE - LONGITUDINAL SECTION

1 - oil sump, 2 - oil sump seal, 3 - oil pump housing, 4 - oil pump cover, 5 - oil pump impellers, 6 - V-belt, 7 - belt pulley for cooling and alternator pump drive, 8 - crankshaft, 9 - gear pulley for injection pump drive and camshaft, 10, 23, 26, 27, 33, 46, 95 - screws, 11 - gearwheel for injection pump drive, 12 - coupling sleeve, 13 - fan, 14 - injection pump, 15 - housing of injection timing adjuster, 16 - weight, 17 - drive shaft of injection pump, 18, 31, 45 - sealers, 19, 39, 63, 68 - nuts, 20 - hub of injection timing adjuster, 21 - toothed belt pulley, 22 - oil filler cap, 24 - belt pulley for cooling pump drive, 25 - flexible cooling pipe, 28 - toothed belt, 29 - timing belt pulley for camshaft drive, 30 - bushing for setting the axial position of the camshaft, 32 - washer, 34 - suction pipe connection, 35 - toothed belt guard for injection pump drive and timing mechanism, 36 - oil filler cap, 37 - vacuum pump housing, 38 - vacuum pump cover, 40 - fuel overflow line, 41 - fuel filter line - injection pump, 42 - vent screw, 43 - fuel line - supply pump - filter, 44 - crankshaft thrust bearing rings, 47 - flywheel cover, 48 - flywheel, 49 - crankshaft bearing shell, 50 - main bearing shell, 51 - main bearing shell seat cover, 52 - oil pump dragon, 53 - oil drain plug, 54 - starter, 55 - crank bar, 56 - starter switching mechanism, 57 - piston, 58 - motor hull, 59 - head, 60 - head gasket, 61 - exhaust pipe, 62 - suction pipe gasket, 64 - valve guide, 65 - suction pipe, 66 - valve spring, 67 - valve lash adjustment screw, 69 - head cap cap, 70 - head cap cap gasket, 71 - head cap cap gasket, 72 - camshaft, 73 - valve lever, 74 - valve lever spring, 75 - guide insert, 76 - bowl, 77 - handle cone, 78 - suction valve, 79 - valve rubber cover, 80 - washer, 81 - injector, 82 - injector gasket, 83 - spray hood, 84 - glow plug, 85 - swirl chamber insert, 86 - oil level gauge, 87 - piston rings, 88 - cylinder sleeve, 89 - oil filter, 90, 93 - gaskets, 91 - oil filter adapter, 92 - injection pump bracket, 94 - supply pump

1 - miska oleju, 2 - uszczelka miski oleju, 3 - obudowa pompy oleju, 4 - pokrywa pompy oleju, 5 - wirniki pompy oleju, 6 - pasek klinowy, 7- koło pasowe napędu pompy układu chłodzenia i alternatora, 8 - wał korbowy, 9 - koło pasa zębatego napędu pompy wtryskowej i mechanizmu rozrządu, 10, 23, 26, 27, 33, 46, 95 - śruby, 11 - kolo zębate napędu pompy wtryskowej, 12 – tuleja sprzęgająca,
13 - wentylator, 14 - pompa wtryskowa, 15 - obudowa przestawiacza kąta wyprzedzenia wtrysku, 16 - ciężarek, 17 - wałek napędu pompy wtryskowej, 18, 31, 45 - uszczelniacze, 19, 39, 63, 68 - nakrętki, 20 - piasta przestawiacza kąta wyprzedzenia wtrysku, 21 - zębate koło pasowe, 22 - korek wlewu oleju, 24 - koło pasowe napędu pompy układu chłodzenia, 25 - przewód elastyczny układu chłodzenia, 28 - pas zębaty, 29 - koło pasa zębatego napędu mechanizmu rozrządu, 30 - tuleja ustalająca osiowe położenie wału rozrządu, 32 - podkładka, 34 - króciec przewodu ssącego, 35 - osłona pasa zębatego napędu pompy wtryskowej i mechanizmu rozrządu, 36 - korek wlewu oleju, 37 - obudowa pompy podciśnieniowej, 38 - pokrywa pompy podciśnieniowej, 40 - przewód przelewowy paliwa, 41 - przewód filtr paliwa - pompa wtryskowa, 42 - wkręt odpowietrzający, 43 - przewód paliwowy pompa zasilająca - filtr, 44 - pierścienie łożyska oporowego wału korbowego, 47 - oslona kola zamachowego, 48 - kolo zamachowe, 49 - panewka łożyska korbowego, 50 - panewka łożyska głównego, 51 - pokrywa gniazda panewki łożyska głównego, 52 - smok pompy oleju, 53 - korek spustowy oleju, 54 - rozrusznik, 55 - korbowód, 56 - mechanizm włączania rozrusznika, 57 - tłok, 58 - kadłub silnika, 59 - głowica, 60 - uszczelka podgłowicowa, 61 - przewód wydechowy, 62 - uszczelka przewodu ssącego, 64 - prowadnica zaworu, 65 - przewód ssący, 66 - sprężyna zaworu, 67 - śruba regulacji luzu zaworowego, 69 - nasada głowicy, 70 - uszczelka pokrywy nasady głowicy, 71 - pokrywa nasady głowicy, 72 - wał rozrządu, 73 - dźwignia zaworu, 74 - sprężyna dźwigni zaworu, 75 - wkładka prowadząca, 76 - miseczka, 77 - półstożek zarnka, 78 - zawór ssący, 79 - osłona gumowa zaworu, 80 - podkładka, 81 - wtryskiwacz, 82 - uszczelka wtryskiwacza, 83 - osłona termiczna rozpylacza, 84 - świeca żarowa, 85 - wkladka komory wirowej, 86 - miarka poziomu oleju, 87 – pierścienie tłokowe, 88 - tuleja cylindrowa, 89 - filtr oleju, 90, 93 - uszczelki, 91 - łącznik filtra oleju, 92 - wspornik pompy wtryskowej, 94 - pompa zasilająca



2.96. Figure: 4C90 ENGINE - CROSS-SECTION

Symbols as in Fig. 2.95.

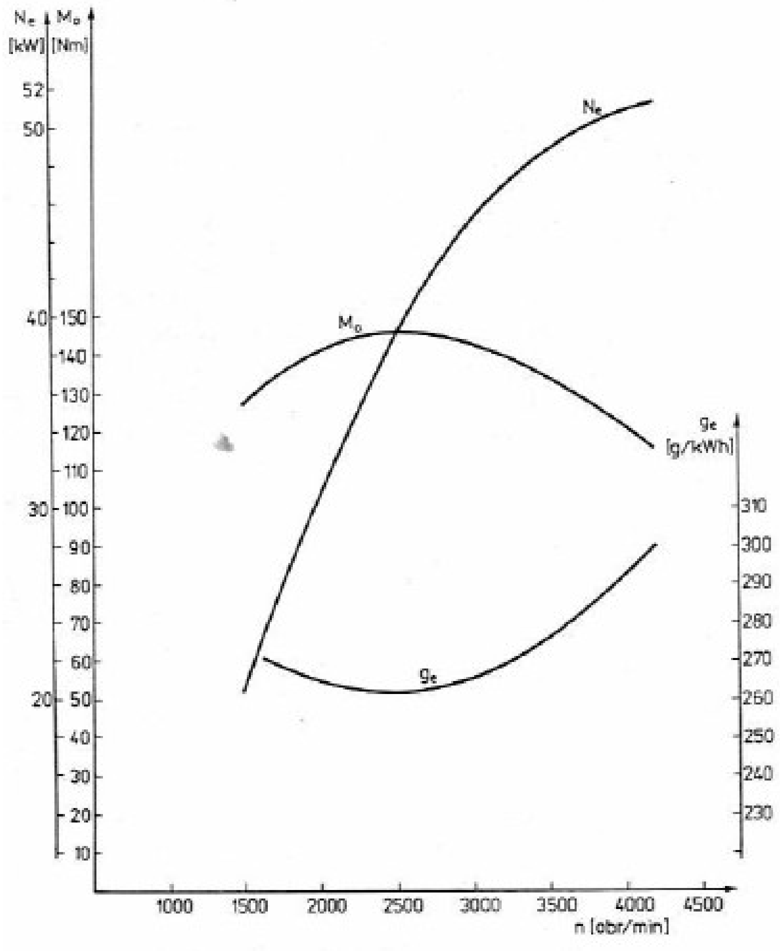
Type	Exhaust gas, piston
Type of fuel	Diesel oil for high-speed engines: summer diesel and winter diesel oil (MA-20, MA-35, MA-50) (depending on the ambient temperature)
Number of stroke strokes	4
Number of cylinders	4
Arrangement of cylinders	in-line
Cylinder diameter	90 mm
Piston stroke	95 mm
Spare volume	2,417 dm^3
Compression ratio	20,6
Rated power	51,5 – 5% kW
Rated power speed	4200 rpm
Maximum torque	145 – 5% N·m
Maximum torque speed	2500 rpm
Motor (drive train) suspension	three-point frame above the axle foremost
Camshaft mechanism:	
- number of suction/exhaust valves	4/4
- valve arrangement	in the head
- placement of the camshaft in the head cap	in the base of the head
- camshaft drive	
Centrifuge chamber	zebra strip
Fuel injection sequence	type RICARDO-COMET VB 1-3-4-2
Fuel system:	
- injection pump	row PP4M7 – self-propelled
- injection angle adjuster	automatic
- injection overtaking angle adjustment range	12° crankshaft rotation
- injector	type Pintaux
- injection pressure	15 ± 0,5 Mpa
- static start of fuel pumping	12° forward of GM
- fuel supply pump	diaphragm type
- fuel filter	with paper cartridge and water separator
- air filter	dry with paper cartridge
Lubrication system:	spray pressure
- oil pump	rotor
- oil pressure	100...400 kPa
- oil filter	zero-regulated, full flow
Crankcase venting system	closed
Cooling system :	closed with forced fluid circulation
- pump	rotary
- radiator	tube and belt radiator
- fan	blade with electromagnetic clutch
Exhaust system :	with silencer
Brake assist system:	vacuum pump

2.46. Table: TECHNICAL CHARACTERISTICS OF THE ENGINE 4C90

The camshaft, which is mounted in a bearing head, is driven by a toothed belt from the crankshaft. The drive shaft of the injection pump is also driven by this belt. The cooling system pump and alternator are driven by a separate V-belt drive from the crankshaft of the engine. On the belt pulley

hub of the cooling system pump there is a fan bearing which is activated by an electromagnetic clutch by the impulses of the thermal sensor installed in the radiator. The motor is equipped with glow plugs for easy starting at low ambient temperatures. The engine also has a vacuum pump (driven by the camshaft) to support the vehicle's service brake system.

The internal structure of the engine is shown in the longitudinal (Fig. 2.95 insert) and transversal (Fig. 2.96 insert) cross-sections, and the external characteristics of the motor run in in in (Fig. 2.97). The engine has a long service life (mileage to the main repair: 250 000...300 000 km).



g_e - specific fuel consumption,
M_o - torque,
N_e - power

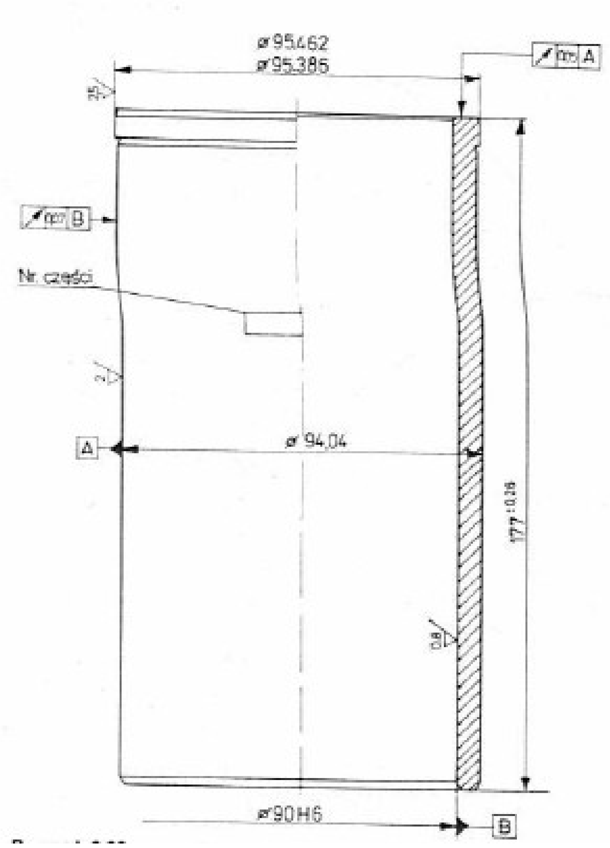
2.97 Figure: 4C90 ENGINE - INTERNAL CHARACTERISTICS

2.3.1 4C90 Hull

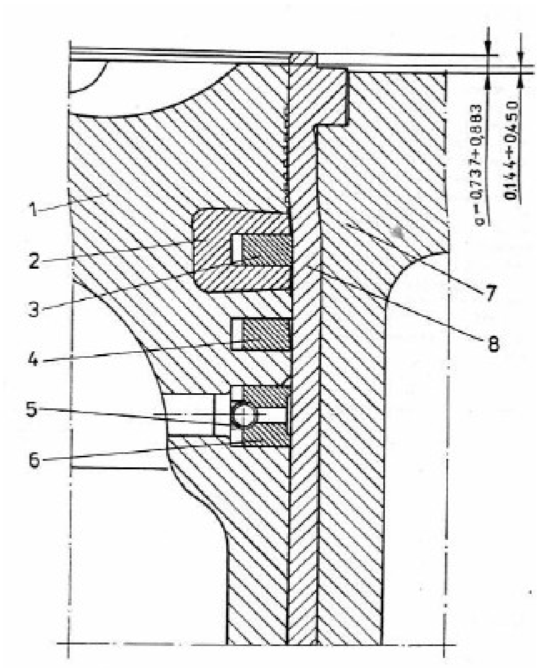
The engine hull shall be a continuous cast iron casting with a minimum wall thickness of 5 mm; its dimensions shall be 444 ± 0,2 mm long, 245_{-02} mm wide and $262{,}2_{-01}$ mm high. The four cylindrical socket outlets for the insertion of the dry cylinder liners shall have a diameter of 94 ± 0,01 mm and their axles shall be 110 ± 0,05 mm apart. The cylinder axes are flush with the thrust axis of the main bearings. The permitted misalignment is ± 0,1 mm. The sockets of the five main bearings are divided. The cast iron covers of these sockets, each bolted down with two M14 screws, have holes with a diameter of $74^{+0.019}$ mm that are bordered together. The sockets shall be marked on the covers and on the hull surface in the same letters of the alphabets A, B, C, D and E. The rear seat of the main bearing ($31.02_{-0.05}$ mm) is wider than that of the others (30 mm) and has a double-sided

$95^{+0,15}_{+0,05}$ mm diameter rolling mechanism to accommodate the split crankshaft thrust bearings fixed prior to rotation by the projections in the lower half rings.

The bottom plate of the crankcase is used to fix the oil sump. This bowl, like the main bearing covers, is processed together with the hull and cannot be associated with another engine. The marking of the jointly treated parts shall consist of the letters of the alphabet A to Z and one of the numbers 1 to 100 and shall be applied on the side surfaces of the hull and of the bowl on the left-hand side of the engine (in the front part). The seat for the rear crankshaft flange seal has an outside diameter of $115^{+0.054}$ mm. Screw holes (10 pcs.) for head mounting have an M12 thread cut, the diameter of the main oil bus in the left wall of the hull is 14 mm, the channels for oil supply to the main bearings of the crankshaft are 7 mm, and for lubrication of the camshaft mechanism in the head, 6 mm. The oil pressure sensor is screwed into the hull into the reducer socket with M12x1.5 thread, and the liquid outlet faucet from the hull cooling system is screwed into M14x1.5 thread. after treatment, the hull is subjected to a water tightness test: water space under



2.98 Figure: SLEEVE



2.99 Figure: POSITION OF THE CYLINDER LINER AND PISTON IN RELATION TO THE UPPER SURFACE OF THE HULL

1-piston, 2-piston cast iron insert. 3.4 - sealing rings. 5 - expansion spring, 6 - scraper ring. 7 - Hull, 8 - Cylinder sleeve

1- tłok, 2 - wkladka żeliwna. 3,4 - pierścienie uszczelniające. 5 - sprężyna rozprężna, 6 - pierścień zgarniający. 7 - Kadlub, 8 - tuleja cylindrowa

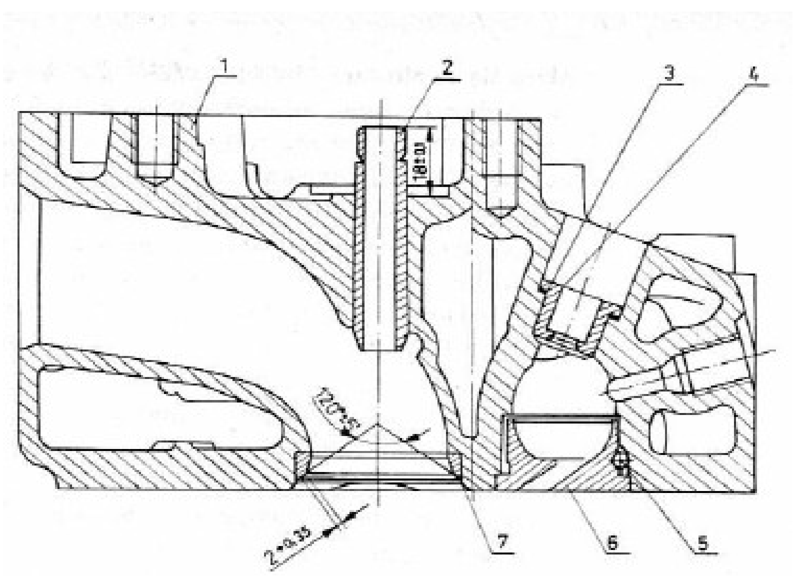
196 kPa pressure and oil channels under 540 kPa pressure. The test period is one minute. Humidity and leaks are not permitted.

The cylinder sleeve (Fig. 2.98) is made as a thin-walled steel roller with an outside diameter of $94{,}04_{-0.02}$ mm and an inside diameter of $90^{+0{,}052}_{+0{,}030}$ mm. The height of the sleeve shall be 177 ± 0,25 mm. Its upper part shall be ended with a flange 4,55...4,60 mm high and 95,382...95,462 mm in diameter.

The ready-made sleeve is pressed into the hull of the press by the force of 6280 N, to the position where its flange surface will project 0.737...0,883 mm above the top surface of the hull (Fig. 2.29). The sleeve is a disposable use, which means that it is excessively worn out. or with other defects it is replaced with a new one.

2.3.2 4C90 Head

The head is a cast iron casting with a wall thickness of 4 mm. The contour dimensions of the head are: length 513 mm, width 200 mm, height $100_{-0.2}$ mm. Holes are made in the lower head plate to fit the valve seats and the so-called hot insole of the swirl chamber, which is the lower part of the swirl chamber. The upper part of the swirl chamber is cast directly into the head material. The diameter of the opening for the suction valve seat is $44^{+0.025}$ mm, for the exhaust valve seat $37^{+0.025}$ mm and for the swirl chamber insert $36^{+0.025}$ mm. The M14x1,5 threaded glow plug socket shall be connected to the swirl chamber by a 6,3 mm channel per filament housing and the spray hood socket shall be $17{,}463^{+0{,}025}$ mm in diameter.



1 - head, 2 - suction valve guide, 3 - isolation gasket, 4 - spray hood, 5 - ball, 6 - swirl chamber insert. 7 - Suction valve seat

1 - głowica, 2 - prowadnica zaworu ssącego, 3 - uszczelka izolacyjna, 4 - osłona termiczna rozpylacza, 5 - kulka, 6 - wkładka komory wirowej. 7 - gniazdo zaworu ssącego

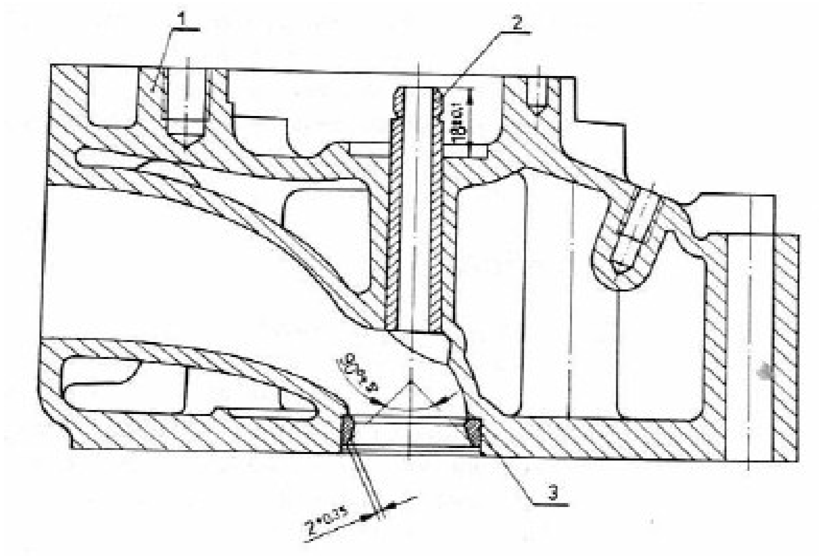
2.100 Figure: CROSS-SECTION OF THE HEAD THROUGH THE INTAKE VALVE SEAT

The inlet and exhaust ducts are led to the right side of the head. The diameter of the holes for fixing the valve stem guide is the same for the suction and exhaust valves and is $14^{+0.018}$ mm.

The **suction** (7, Fig. 2.100) and exhaust (3, Fig. 2.101) valve seats, made of special cast iron, are shrunk in the head after they have been cooled down in liquid nitrogen.

2.3.2 4C90 Head

The **cast iron guides**, shorter for the suction valve (2, Fig. 2.100) and longer for the exhaust valve (2, Fig 2.101) and the swirl chamber insert, made of a special NIMOCAST alloy (Fig. 2.102), and the spray hood (4, Fig. 2.100) are mounted in a compression head.



1 - head, 2 - exhaust valve guide, 3 - exhaust valve seat

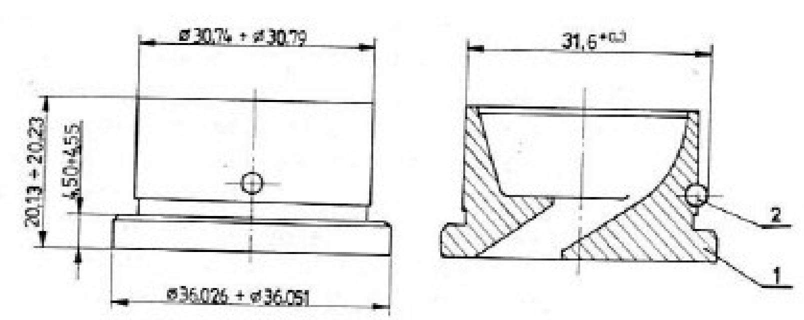
1 - głowica, 2 - prowadnica zaworu wydechowego, 3 - gniazdo zaworu wydechowego

2.101 Figure: CROSS-SECTION OF THE HEAD THROUGH THE EXHAUST VALVE SEAT

To ensure that the swirl chamber insert is correctly positioned in relation to the recess in the piston crown, it is pressed together with a 3 mm diameter ball (5, Fig. 2.100) mounted on the piston crown along a special channel at an angle of 30° to the longitudinal axis of the head. The flaps of the valve seats shall be finally ground when seated in the head in co-axial fashion with the guide axes for the dimensions defined in Figures 2.100 and 2.101. The cooling space of the head shall be connected to the cooling space of the engine hull through the openings in its lower plate. In this plate, the water is directed first to the hottest spots through special steering wheels, i.e. to the hot inserts of the swirl chambers and exhaust valve seats, and only after they have cooled down, it flows towards the thermostat and returns to circulation.

1 - insert,
2 - retaining ball

1 - wkladka,
2 - kulka ustalająca



2.102 Figure: SWIRL CHAMBER INSERT

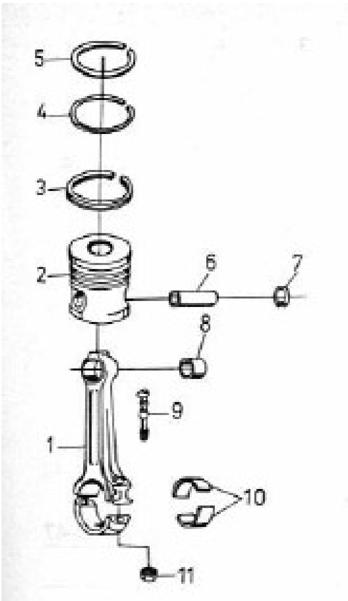
The tightness of the head shall be checked for 1 minute with water at room temperature at a pressure of 0,5 MPa. Humidity and leaks are not permitted. The head is attached to the engine hull by means of a gasket with eighteen nuts M12x1,25.

2.3.3 4C90 Head cap

■ The head cap is a cast aluminium alloy with a wall thickness of 5 mm. In five sockets with a diameter of $50^{+0.025}$ mm, the camshaft is mounted on a bearing. The front seat has a diameter of $66^{+0.046}$mm for the shaft alignment sleeve, and a diameter of $68^{+0.046}$mm for the rear seat for the vacuum pump housing. The lengthwise oil channel with a diameter of 6 mm has branches with a diameter of 4 mm for lubricating camshaft pivots and feeding the vacuum pump, and with a diameter of 1 mm for spraying lubrication of camshaft cams. A nozzle with four 1,5 mm radial openings and a 2,5 mm axial channel is fitted at the inlet to the longitudinal channel to dose the quantity of lubricating oil. The nozzle is enclosed in a filter grid. The cap is attached to the head by a Polonite PP gasket on nine stud bolts and M10 nuts.

■ The cover of the head cap, made as a thin-walled cast aluminium alloy, is screwed to the base with two special nuts M8, at the rear there is a shaped oil filler throat with a plug, at the top - a cylinder with an internal diameter of 30 mm, ended with a threaded hole M16x1,5, for screwing in the pipe connector of the ventilation system of the engine crankcase.

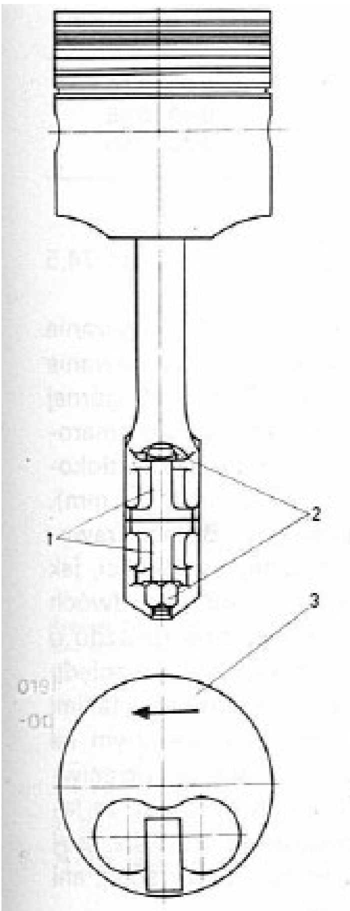
2.3.4 4C90 Crankshaft piston mechanism



2.103 Figure: CRANKSHAFT PISTON

1 - connecting rod, 2 - piston, 3 - scraper ring, 4,5 - sealing rings, 6 - pin, 7 - protective ring. 8 - crankcase sleeve, 9 - crankcase screw, 10 - crankcase semiconductor semiconductor semiconductor. 11 - nut

1 - korbowód, 2 - tłok, 3 - pierścień zgarniający, 4,5 - pierścienie uszczelniające, 6 - sworzeń, 7 - pierścień zabezpieczający. 8 - tulejka tba korbowodu, 9 - śruba korbowodu, 10 - półpanewki korbowodu. 11 - nakrętka



2.104 Figure: PISTON ASSEMBLY KIT WITH CRANK HANDLE

1 - crankshaft and cover identification marks punctured on the injection pump side,
2 - points on the bolt and nut on the identification marks side,
3 - arrow on the bottom indicating the front of the engine

1 - znaki identyfikacyjne korbowodu i pokrywy wybite od strony pompy wtryskowej,
2 - punkty na śrubie i nakrętce od strony znaków identyfikacyjnych,
3 - strzałka na denku toka wskazująca przód silnika

2.3.4 4C90 Crankshaft piston mechanism

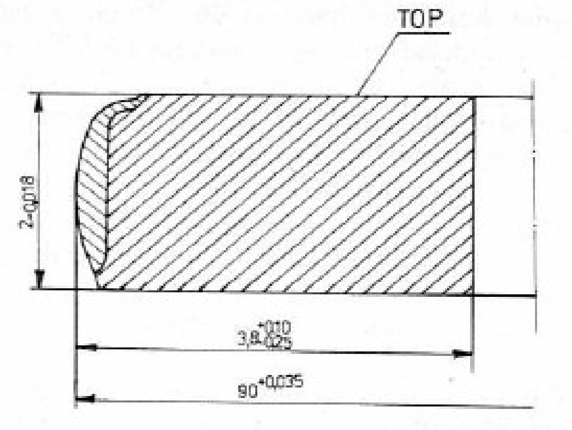
The crankshaft mechanism consists of four pistons, crankshafts and a crankshaft. The piston rod set with crankshaft (Fig. 2.103) includes:

- piston 1 pcs.
- crank ducting 1 pcs.
- crank handle half shell 2 pcs.
- crank handle screws and nuts 2 pcs.
- piston rod 1 pcs.
- safety rings piston pin 2 pcs.
- upper sealing ring 1 pcs.
- lower sealing ring 1 pcs.
- scraper ring 1 pcs.
- crank duck sleeve 1 pcs.

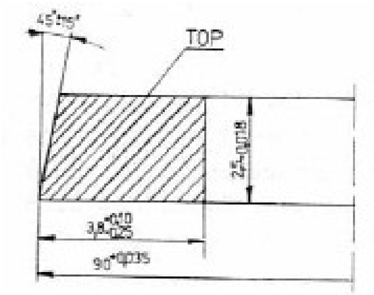
■ The pistons are made as castings of aluminium alloy. The piston, when heated to 70 °C, is mounted with a crankshaft, as shown in Figure 2.104. The piston sidewall is a conical shape with a 0,07 mm ring section and a 0,50 mm guide section in the cross-section of the piston. The diameter of the piston, measured in a plane perpendicular to the axis of the piston pin 79,5 mm from the piston crown, shall be 89,950 mm and shall determine its nominal diameter. The height of the piston is 92 mm. The holes in the hubs for the piston rod bearing are $30^{+0.008}_{+0.003}$ mm in diameter. The piston rod selections, which are part of the combustion chamber, shall have a volume of 3,8 ± 0,5 cm. The grooves for the piston rings are made directly in the piston material, except for the first sealing ring (from the piston crown), which has a groove made in the cast iron insert (2, Fig. 2.99) immersed in the piston.

■ The sealing rings (Fig. 2.105 and 2.106) of the chrome-plated sliding piston are mounted on the marked "TOP" or "G" sides towards the piston crown. The scraper ring (fig. 2.107) is mounted on either side of the bottom but with the coupling of the scraper spring on the opposite side of the lock. The normal axial clearances of the rings in the piston grooves are given in Table 2-47 and the rings shall meet the technical conditions specified in Table 2-48.

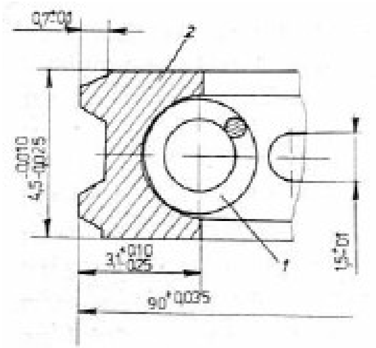
■ The piston rod, made of alloyed steel for carburizing, is of floating type, i.e. the crank-and-rope connection is made in 0.030 loose... 0.042 mm and pin-hub connection in piston with 0.030 mm clearance. 0,058 mm. The diameter of the pin shall be $30_{-0,05}$ mm and the length 74,5 mm.



2.105 Figure: UPPER SEAL RING (I) (PIERŚCIEŃ USZCZELNIAJĄCY GORNY)



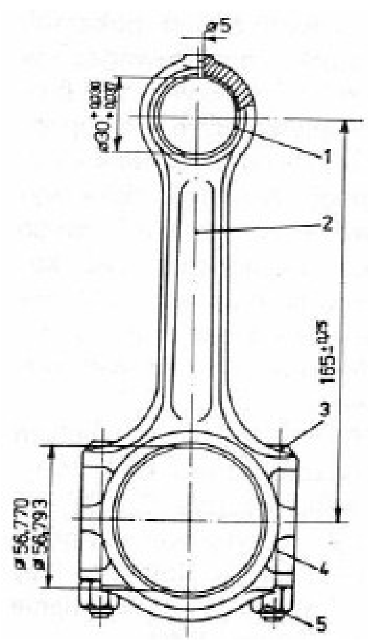
2.106 Figure: LOWER SEALING RING (II) (PIERŚCIEN USZCZELNIAJĄCY DOLNY)



2.107 Figure: SCRAPER RING (III) (PIERŚCIEN ZGARNIAJĄCY)

1 - spring,
2 - ring

1 - sprężyna,
2 - pierścień



2.108 Figure: SCRAPER RING (III) (PIERŚCIEN ZGARNIAJĄCY)

1 - sleeve,
2 - crankshaft shaft,
3 - crankshaft screw,
4 - cover,
5 – nut

1 - tuleja,
2 - trzon korbowodu,
3- śruba korbowodu,
4 - pokrywa,
5 - nakrętka

Ring	Lash, mm
Upper sealing ring (I) Lower sealing ring (II) Scraper ring (III)	0,050...0,090 0,040...0,078 0,045...0,085

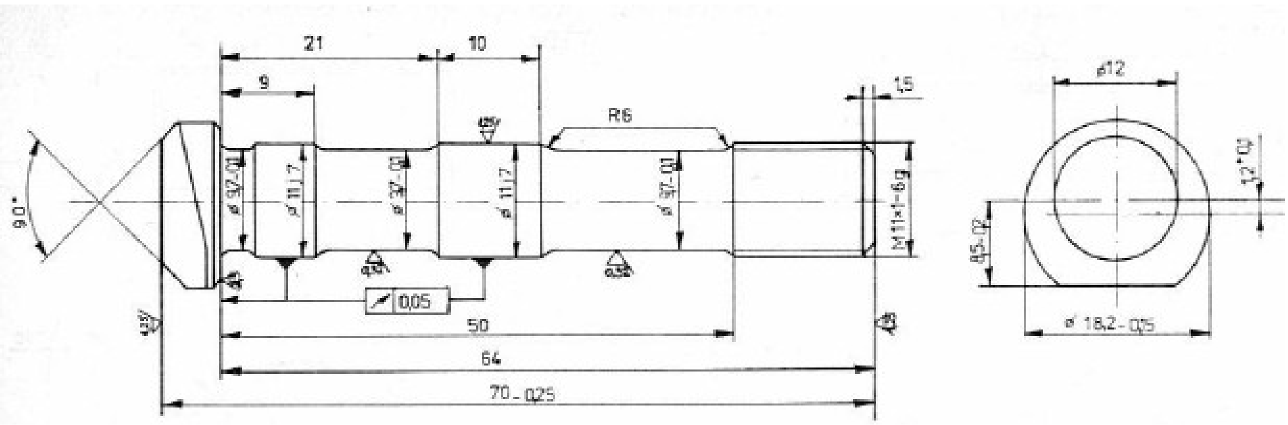
2.47 Table: AXIAL CLEARANCE OF THE RINGS IN THE PISTON GROOVES

Ring	Tangential force on lock, N	Lock clearance, mm
Upper sealing ring (I) Lower sealing ring (II) Scraper ring (III)	13,1...19,7 16,3...24,5 44...61,6	0,40...0,65 0,40...0,65 0,30...0,30

2.48 Table: CLEARANCES IN PISTON RING LOCKS

■ The crankshafts (Fig. 2.108) are forgings made of alloy steel for heat treatment. The sleeve (1) of the piston rod bearing arrangement is pressed into the crankshaft head. The diameter of its socket is $34^{+0.025}$ mm. In the upper part of the head there is a 5 mm diameter hole for oil lubrication of the cooperating sliding surfaces of the piston pin and bearing sleeve (internal diameter is $30^{+0.037}_{+0.030}$ mm). The stem of the crankshaft (2) has an I-beam cross-section. The sides and edges of the shank are ground. The crankshaft head of the same width as the head ($32^{-0.18}_{-0.25}$ mm), after being screwed to the cover (4) with two special crankshaft screws (fig. 2.109), has a machined socket of $58,5^{+0.013}$ mm diameter for mounting the crankshaft half shells. Due to the joint processing, the cover and the shaft form a set marked with the same alphabet letters and numbers, marked in the place shown in Figure 2.104, Item 1. Bolts and nuts of the crankshaft, located on the opposite side of the notches to determine the protrusions of the socket before rotation, are marked with a point. Screws and nuts used and marked in the manufacturing process must not be replaced or fitted (during repair) to another connecting rod.

The length of the centre line of the headstock from the Iba axis shall be 165 ± 0,025 mm. Depending on the distribution of the total weight (between head and left), the complete crankshaft is selected into mounting groups. The permissible weight difference for one set of crankshafts weighed in the crankshaft tba axis with rotary support in the bushing hole axis in the head is 25 g. The crankshafts of the same selection group are mounted on one motor.



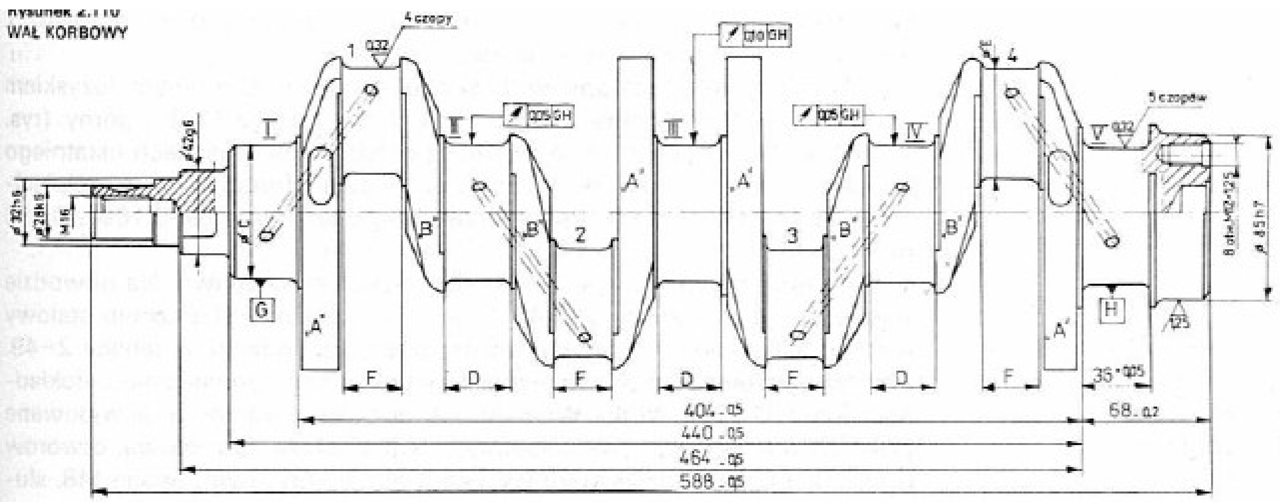
2.109 Figure: CRANK HANDLE SCREW

2.3.4 4C90 Crankshaft piston mechanism

■The crankshaft (Figure 2.110) forged from alloyed steel shall have the main and crankpin shaft in the same plane and shall be arm-linked, the first, fourth, fifth and osme of which shall be fitted with an "A" counterweight for dynamic shaft balancing to within 0,005 N·m. Unbalances greater than those specified are eliminated by drilling holes with a diameter of 15 mm into the counterweights.

The five ground and lapped stub shafts have a diameter of $ØC=70_{-0019}$ mm and the four crankpins have a diameter of $ØE=55_{-0.019}$ mm. The main and crankpins are nitrided (layer thickness 0.25...0.4 mm) to achieve the required hardness (minimum 620 HV) and wear life.

The width of the main pivots shall be $D=36^{+0,250}$ mm and of the crankshaft pivots shall be $F=32^{+0,100}$ mm. To ensure proper lubrication of the main and crankshaft bearings, the pivots and arms are provided with oil channels with a diameter of 6.3 mm. At the front end of the shaft there is a $28^{+0.018}_{+0.002}$ mm pin with a $5^{+0.016}_{+0.018}$ mm wide keyway for fixing the gears of the injection pump and camshaft drive and the alternator drive and the cooling pump, as well as a $42^{-0,009}_{-0,025}$ mm pin for fixing the internal impeller of the oil pump. At the rear end of the shaft there is a flange made for fixing the flywheel. The cylindrical flange surface with a diameter of $85_{-0.035}$ mm is ground using an oscillating method. The flywheel shall be mounted on eight M12x1,25 bolts spaced 62 ± 0,1 mm in diameter, and a locking pin of 8 mm in diameter with an axis shifted 22,5 ± 15' in the axis of the aforesaid crankpin shall be mounted in relation to the first crankpin.

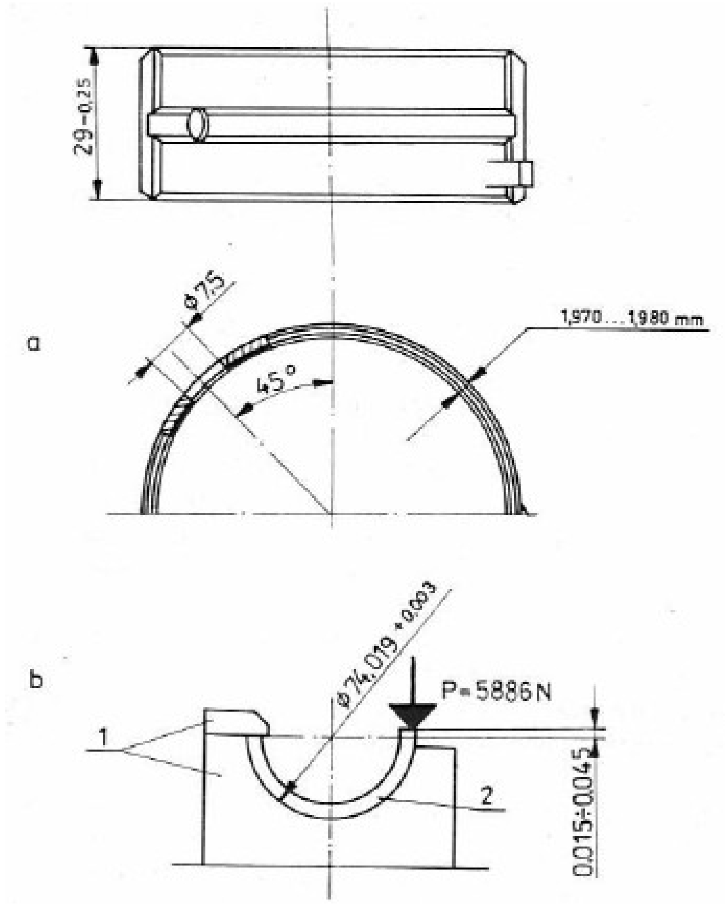


2.110 Figure: CRANKSHAFT

■ The main bearing shells (Fig. 2.111) and the crankshaft bearing shells (Fig. 2.112) are made as replaceable steel inserts, poured out with a bearing alloy. The wall thickness of the main pan is 1,970...1,980 mm and 1,720...1,730 mm for the crankshaft. The accuracy of the bearings is ensured by the possibility of their assembly, without additional adjustment with pivots. The mounting clearance for the main panes is 0,040..0,098 mm and for crankshafts 0,040...0,092 mm. In order to ensure that the half-panes are fully seated in the seats, the half-panes, when tested in a measuring instrument and loaded with a force of "P", shall have the tolerances shown in Figures 2.111(b) and 2.112(b). The main pan on the sliding side shall have holes and circumferential oil grooves and the crank shells shall be smooth. They are protected against axial displacement by the preload caused by the tightening torque of the main bearing retainer screws and the crankcase screws, and against rotation by the protrusions created at the splitting edge.

2.3.4 4C90 Crankshaft piston mechanism

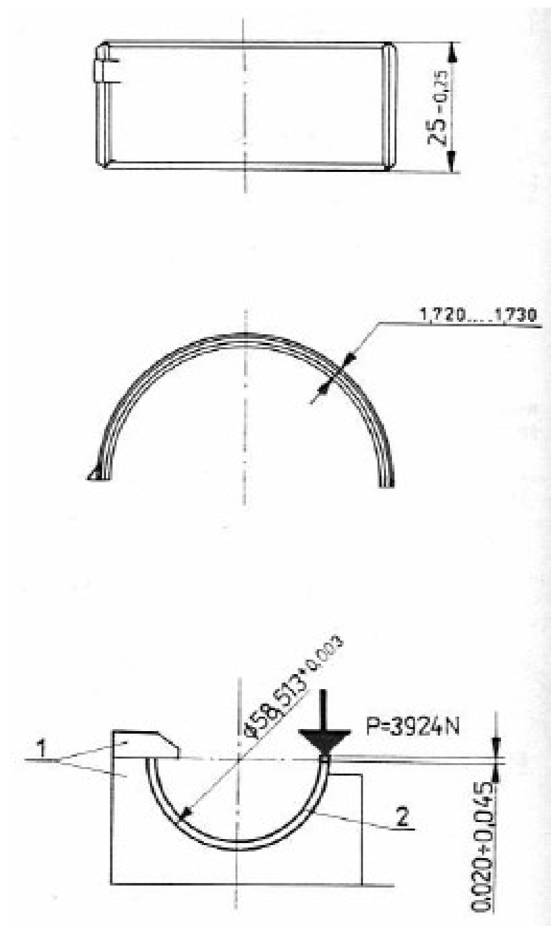
The crankshaft is fixed in the axial direction of the thrust bearing. The lower (Fig. 2.113) and upper (Fig. 2.114) half-rings of this bearing, poured with a bearing alloy, are seated in the sockets of the last bearing and secured against rotation by a fin formed in the lower half-right. The longitudinal clearance of the assembled shaft is 0,180...0,350 mm.



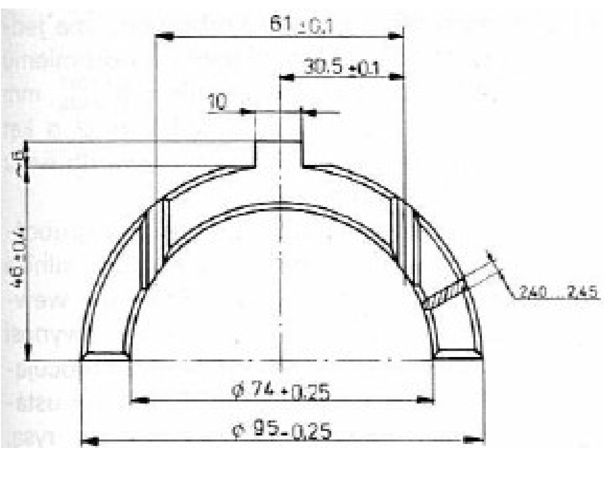
2.111 Figure: MAIN BEARING SHELL (PANEWKA ŁOŻYSKA GŁÓWNEGO)

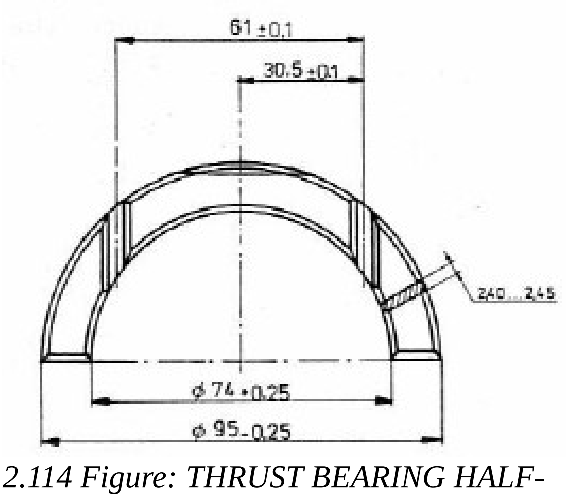
a - basic dimensions, b - measurement in the test, 1 - test. 2- half-panel

a - podstawowe wymiary, b - pomiar w sprawdzianie, 1 - sprawdzian. 2- pólpanewka



2.112 Figure: CRANKSHAFT BEARING SHELL (PANEWKA ŁOŻYSKA KORBOWEGO)





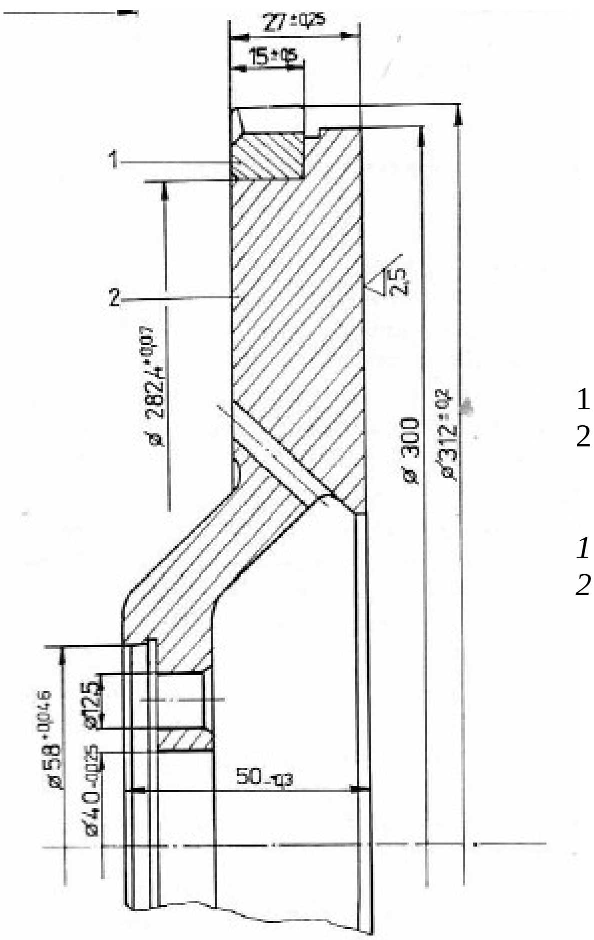
2.113 Figure: THRUST BEARING HALF-RING (LOWER)

2.114 Figure: THRUST BEARING HALF-RING (UPPER)

■ The flywheel (2, Fig. 2.115) is made of cast iron. The outer circumference of 282.4$^{+0.07}$ mm has a shrink-fitted steel gear ring (1) with the tooth characteristics specified in table 2-49, which is dynamically balanced to an accuracy of 0,0035 N·m. Larger unbalances are eliminated by drilling holes with a diameter of 8...10 mm for 225 mm on the side cooperating with the clutch disc. The M8 threaded holes, which are used to fix the coupling with six screws, are evenly spaced in pairs over a diameter of 263.5 mm. The outer circumference of the wheel is marked with "GMP" and a 2° graduated cut-off scale with the figures "6" and "14", which are distinguished at the beginning and end of the cylinder, to enable precise positioning of the piston 1 in ZZ or the static pre-injection angle. The wheel in relation to the crankshaft shall have an unambiguous angular position. Between the fixing holes within a radius of 31 ± 0,05 mm there shall be a fixing hole with a diameter of $8^{+0,047}_{+0,025}$ mm offset from the mark 'GMP' by an angle of 7° 30' ± 15' and an angle of 22,5° ± 15' from the hole fixing the flywheel to the shaft and situated in the crankpin centre of 1 cylinder.

Number of teeth	102
Module	3 mm
Diameter of the indexing wheel	305,6 mm
Angle of support	15°
Wreath width	14,5...15,5 mm

2.49 Table: CHARACTERISTICS OF THE PINION ON THE FLYWHEEL



1 - toothed ring,
2 – flywheel

1 - wieniec zębaty,
2 - koło zamachowe

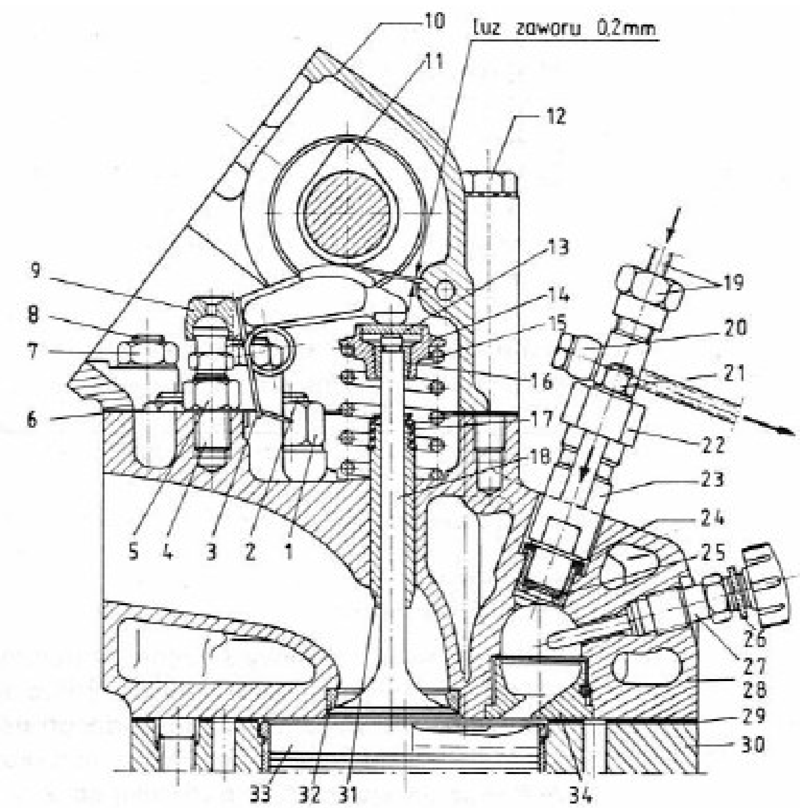
Figure 2.115: FLYWHEEL (KOŁO ZAMACHOWE)

2.3.4 4C90 Crankshaft piston mechanism

■ The flywheel housing made of aluminium alloy with a minimum wall thickness of 6 mm is attached to the rear wall of the engine hull and used to screw on the clutch and starter housing. The internal diameter of the casing (per flywheel room) is $314{,}325^{+0.130}$ mm and its depth is 27 mm. There are two windows on the circumference of the mounting flange, which allow to observe the setting marks on the flywheel. The center of the window is marked with a cracks. The mounting socket for the starter has a diameter of $89^{-0.037}_{-0{,}091}$ mm and three M10 threaded holes for fastening screws.

2.3.5 4C90 Timing mechanism

The timing mechanism (Fig. 2.116) comprises the camshaft (11), the valve levers (9), the lever springs (3), the adjusting screws (4), the suction and exhaust valves (18) and the valve springs (15). The camshaft mechanism is driven by a timing belt from the crankshaft. The drive ratio is 1:2. In order to enable unambiguous and repeatable adjustment of the camshaft, the cast iron gear mounted on the camshaft is equipped with setting marks (grooves of the "V" type on the wheel centre moved from the axle to the keyway by 45°±30') which, when adjusted, align with the setting mark (scratch) made on the face of the bushing determining the longitudinal clearance of the camshaft in the head base. The toothed belt used ensures quiet operation of the camshaft drive.



1, 5, 7, 21 - nuts, 2, 8, 12 - bolts. 3 - valve lever spring, 4 - valve lash adjustment screw. 6 - head cap gasket. 9 - valve lever, 10 - head cap, 11 - camshafts. 13 - guide insert. 14 - bowl, 15 - valve spring, 16 - lock half cone, 17 - valve rubber cover, 18 - valve, 19 - high pressure hose, 20 - bypass hose, 22 - yoke, 23 - injector, 24 - injector gasket, 25 - nozzle gasket. 26 - electric cable, 27 - glow plug, 28 - head, 29 - head gasket. 30 - motor hull, 31 - valve guide, 32 - valve seat. 33 - piston, 34 - swirl chamber insert

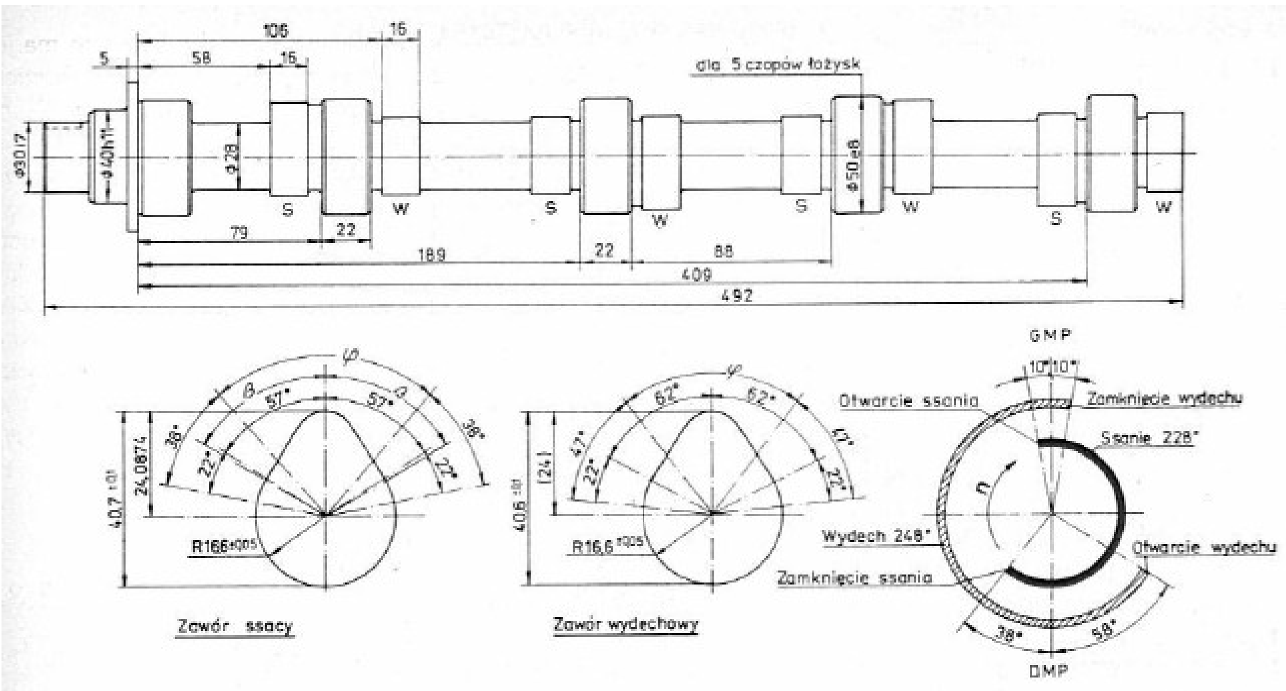
1, 5, 7, 21 - nakrętki, 2, 8, 12 - śruby. 3 - sprężyna dźwigni zaworu, 4 - śruba do regulacji luzów zaworów. 6 - uszczelka nasady glowicy. 9 - dźwignia zaworu, 10 - nasada głowicy, 11 - wal rozrządu. 13 - wkładka prowadząca. 14 - miseczka, 15 - sprężyna zaworu, 16 - pólstożek zamka, 17 - oslona gumowa zaworu, 18 - zawór, 19 - przewód wysokiego ciśnienia, 20 - przewód przelewowy 22 - jarzmo, 23 - wtryskiwacz, 24 - uszczelka wtryskiwacza, 25 - uszczelka rozpylacza. 26 - przewód elektryczny, 27 - świeca żarowa, 28 - głowica, 29 - uszczelka głowicy. 30 - kadłub silnika, 31 - prowadnica zaworu, 32 - gniazdo zaworu. 33 - tłok, 34 - wkladka komory wirowej

2.116 Figure: TIMING MECHANISM

■ The camshaft (Fig. 2.117), made as a special cast iron, is mounted directly on five pivots of 50-0.050-0.089 mm diameter, in the material of the head cap. The pivots are hardened by whitening to a minimum hardness of 45 HRC. The cams on the suction (s) and exhaust (w) valves shall be arranged between the pivots and shall have the outline shown in the figure. The angular spacing of the cam axis, measured from the groove of the inlet to the V-belt pulley, is for 1 cylinder: the suction cam in the groove axis (misalignment permitted ± 30°), the exhaust cam 109°, and for the

remaining cylinders every 90° from these positions in the direction opposite to the direction of rotation of the shaft and in the order of operation of the cylinders 3-4-2.

The diagram of the camshaft phasing unit is shown in Figure 2.117 (the graph is drawn up with a test play between cam and lever of 0.3 mm). The front shaft journal with a diameter of 30+0.013-0.008 mm has a groove for 6x6x14 mm keyway which locks the drive gear and a central M16 threaded hole for the fastening screw. An M10 threaded hole is provided in the rear journal for screwing in the fin that drives the vacuum service brake booster pump. The camshaft is fixed axially with the front bushing (with shaft seal sockets) screwed to the head cap on the two M8 screws, with a correct axial clearance of 0.12...0.27 mm. Bearings and cams are lubricated with oil fed via channels to the head cap.

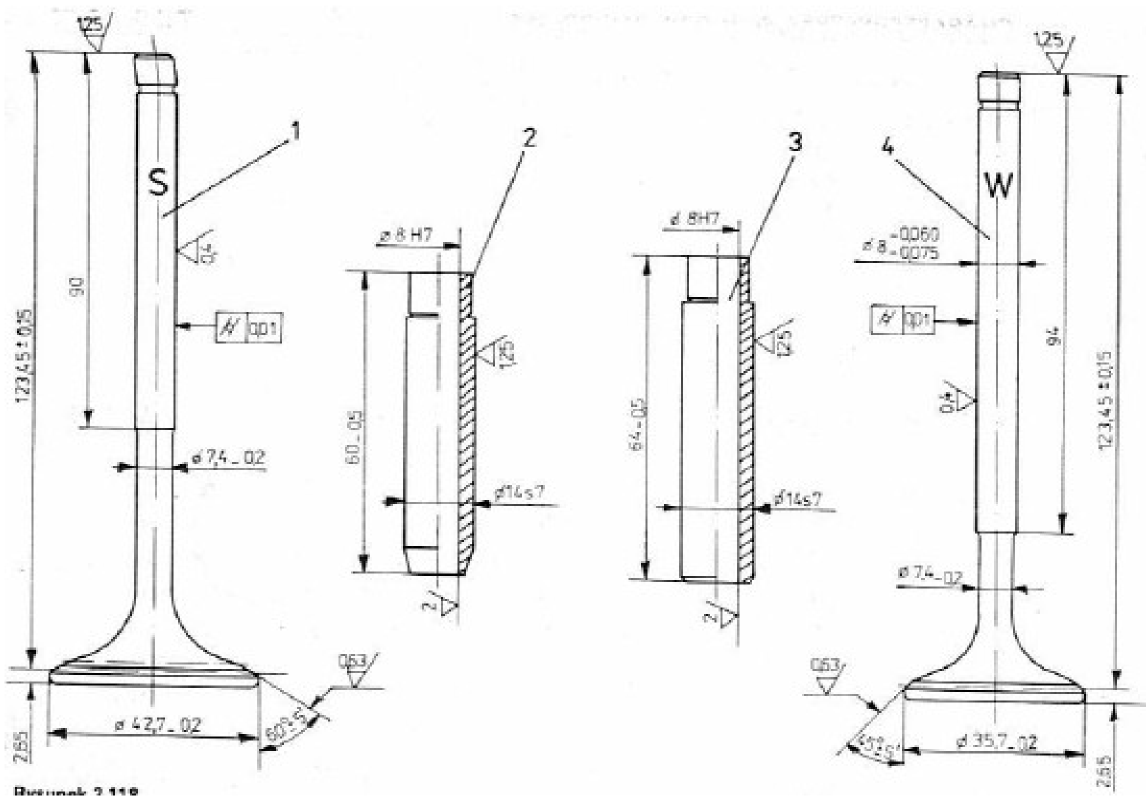


2.117 Figure: CAMSHAFT

ZZ - external piston return, ZW - internal piston return,n - direction of rotation, s - cam on the suction tap, w - cam of exhaust valve

ZZ - zwrot zewnętrzny tloka, ZW - zwrot wewnętrzny tloka, n - kierunek obrotów, s - krzywka zaworu ssącego, w - krzywka zaworu wydechowego

■ The single arm valve levers (9, Fig. 2.116) are made of special cast iron. The ball socket (ball diameter $14^{+0.12}$ mm) for the adjusting screw has a 4,0 mm grease channel at the top. The surface to be worked on by the cam shall be shaped by a radius of 25 ± 0,12 mm and the surface to be worked on by the valve guiding insert by a radius of 11 ± 0,1 mm. These surfaces are hardened by bleaching. The I section of the shank has a notch $1{,}25^{+0.12}$mm wide and 1,5mm deep cut near the spherical seat, along which, for example, in the event of a toothed belt breakage, the camshaft drive breaks down the lever, preventing serious damage to the crankshaft system and other components of the camshaft.



1 - Suction valve,
2 - Suction valve guide,
3 - Exhaust valve guide,
4 - Exhaust valve.

1 - zawór ssący,
2 - prowadnica zaworu ssącego,
3 - prowadnica zaworu wydechowego,
4 - zawór wydechowy

2.118 Figure: VALVES WITH GUIDES

■ The valve lever adjusting screws (4, Fig. 2.116) made of alloyed steel for carburizing are ended with a ball $14_{-0.12}$ mm in diameter. A 15 mm hexagonal key is formed underneath the ball. The shank is fully cut to M12x1,25 mm thread height.

■ Inlet and exhaust valve seats and valve guides are discussed in Section 2.3.2.

■ Suction valves (1, 2.118), made of structural alloy steel for thermal upgrading and exhaust (4, 2.118), made of special heat-resistant steel with stellited joints, have different mushroom dimensions and the length of the chrome-plated parts of the handles cooperating with the guides. The valves shall be heat treated to a hardness of 26...33 HRC for the suction valve and a minimum of 340 HV for the exhaust valve. The total length of both valves is the same. They also have the same handle diameters and are mounted with the same lateral play (0,060...0,090 mm) in the guides. Valve shafts are fitted with covers (17, Fig. 2.116) to prevent oil from entering the combustion chambers along the shafts. The valve locks consist of two steel half cones (16, Fig. 2.116) pressed together in a spring cup (14, Fig. 2.116). The apex angle of the cone shall be 10° ± 15'. In the upper part of the bowl there is a socket for the room of the steel guiding insert (13) with a diameter of $20^{-0.03}_{-0.06}$ mm and a longitudinal groove with a width of 14 mm for the valve lever room.

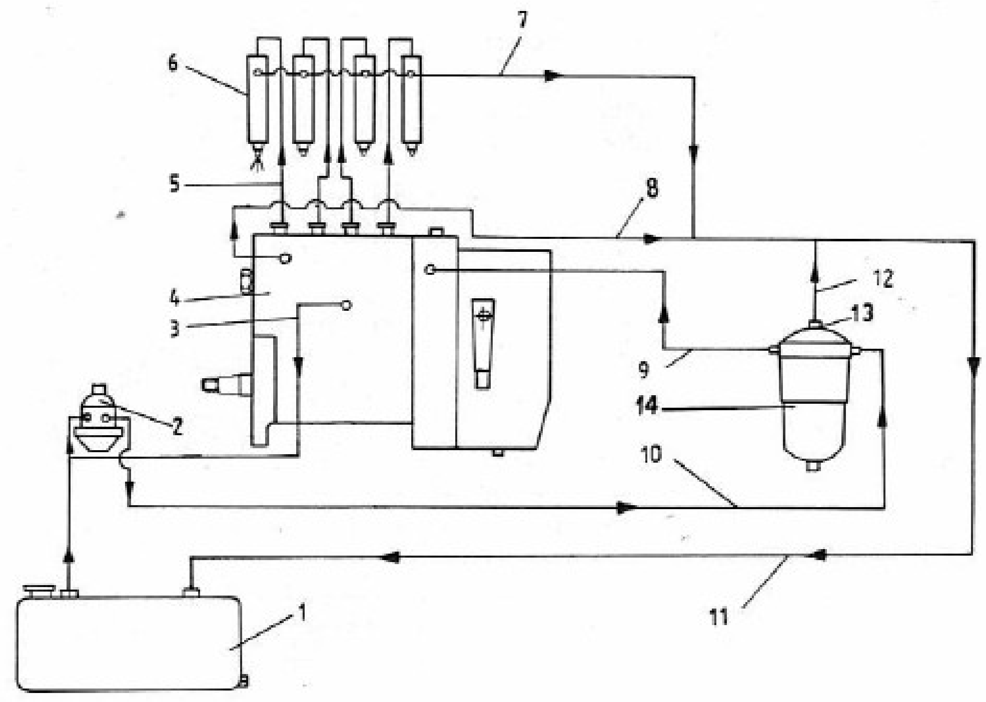
■ The springs of the suction and exhaust valves (15, Fig. 2.116) are made of steel wire with a diameter of 5 mm. The technical characteristics of the spring (identical for both valves) are given in Table 2-50.

Total number of reels	6,5
Active number of coils	4,5
Installation length	46 mm
Compressed force to a height of 35 mm	802 N
Direction of retraction	right
Frequency of natural vibrations	428 Hz

2.50 Table: VALVE SPRING CHARACTERISTICS

2.3.6 4C90 Air/Fuel Supply

The 4C90 engine power supply system (Figure 2.119) includes the fuel tank (1), the supply pump (2), the fuel filter (14), the injection pump (4), the high pressure hoses (5), the injectors (6) and the overflow (excess) lines from the injectors, the injection pump and the fuel filter. The air for the engine is sucked through an air filter with a dry filter element.



1 - fuel tank, 2 - fuel pump (supply), 3, 7, 8, 11, 12 - overflow lines, 4 - injection pump. 5- high pressure line, 6 - injector, 9 - fuel filter line - injection pump. 10 - cable supply pump-filter supply pump-filter. 13 - vent screw, 14 - fuel filter

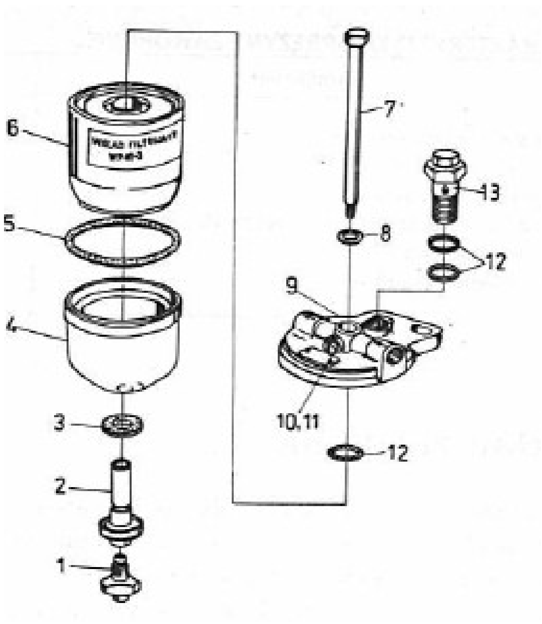
1 - zbiornik paliwa, 2 - pompa paliwa (zasilająca), 3, 7, 8, 11, 12 - przewody przelewowe, 4 - pompa wtryskowa. 5- przewód wysokiego ciśnienia, 6 - wtryskiwacz, 9 - przewód filtr paliwa - pompa wtryskowa. 10 - przewód pompa zasilająca-filtr. 13 - wkręt odpowietrzający, 14 - filtr paliwa

2.119 Figure: SCHEME OF 4C90 ENGINE FUEL SUPPLY

■ The 55 dm^3 fuel tank for versions D and I is built in the same way as the other car tanks, with the difference that in the dragon's lid of the fuel there is an additional nozzle soldered to connect the collective overflow line (11).

■ The diaphragm feed pump is a modification of the fuel pump described in section 2.2.5. It is driven by an eccentric cam on the drive shaft of the injection pump. It has an independent manual drive for venting the motor power supply.

■ The fuel filter (Fig. 2.120) consists of a housing (4) which is a settling tank with a built-in water drain valve (1, 2), a cover (9) and a filter insert (6) from below. The lid joint is sealed with a gasket (5) and both parts are bolted together with an M8 centre bolt, 100 mm long (7).



1 - the plug of the drain valve,
2 - the valve housing.
3, 5, 8, 11, 12 - seals,
4 - filter housing (settling tank),
6 - filter insert,
7, 13 - screws,
9 - filter cover,
10 - vent screw

1 - grzybek zaworu spustowego,
2 - obudowa zaworu.
3, 5, 8, 11, 12 - uszczelki,
4 - obudowa filtru (osadnik),
6 - wklad filtracyjny,
7, 13 - śruby,
9 - pokrywa filtru,
10 - wkręt odpowietrzający

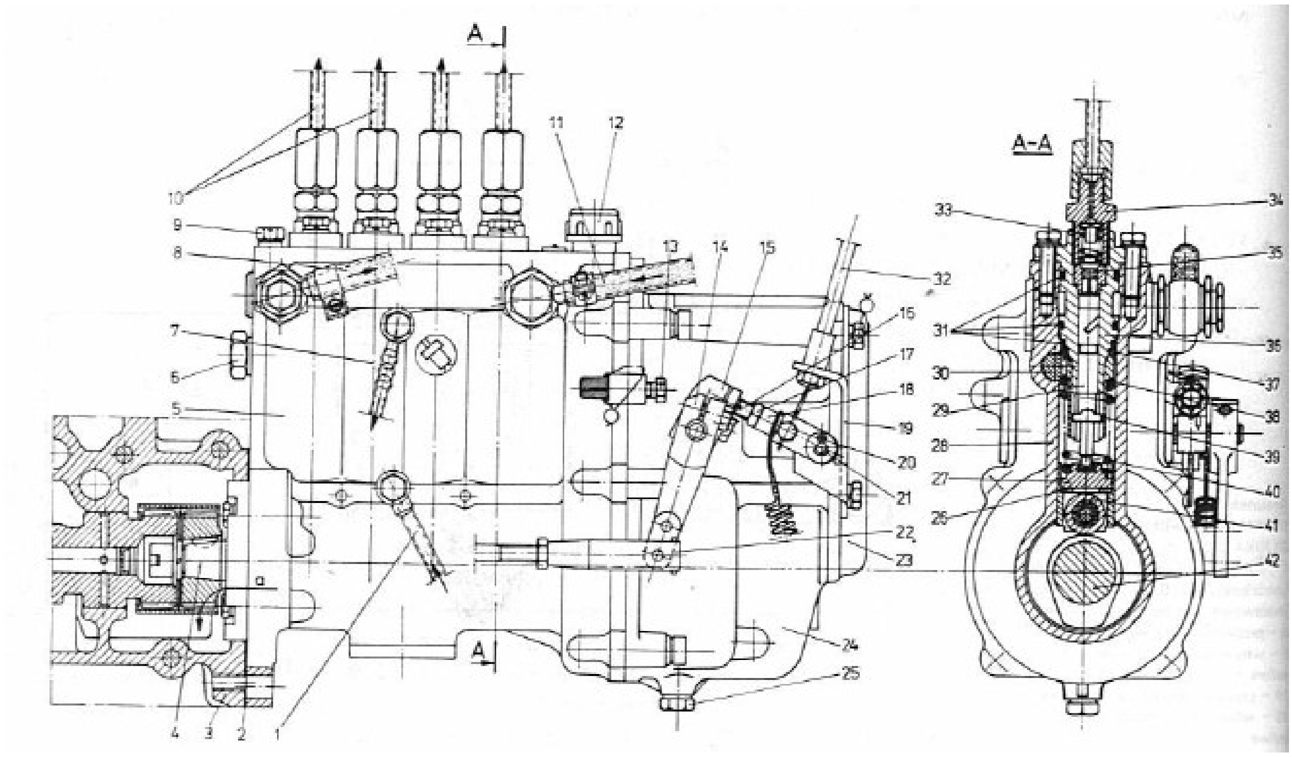
2.120 Figure: FUEL FILTER (FILTR PALIWA)

■ The small injection pump (Fig. 2.121) is a in-line four-section pump with the technical characteristics specified in Tables 2-51 and 2-52. Individual letters and figures in the identification number of the pump, e.g. PP4M7P1ę 3097, indicate:

- P - injection pump,
- P - flange mounting,
- 4 - number of discharge sections,
- M - pump size (see tables 2-51),
- 7 - nominal piston diameter,
- P - constant start of pressing (right-hand piston),
- 1 - assembly system,
- e - execution (model) see table 2-51,
- 3097 - Installation documentation number.

The aluminium alloy pump housing is made as a uniform casting with a speed controller housing.

At the bottom of the housing, on two 6303 ball bearings, a cam roller is mounted to control the operation of the four discharge sections. Each section consists of an EM7Pe marked press element (pistons and cylinders) and an ATLAS type press valve (mushroom and seat), known as precision pairs, due to the high accuracy of the workmanship and the low backlash between the cooperating parts. In the PP.M.e. pumps, a cylinder (36), made as a whole with an outlet for the discharge valve, is attached to the pump casing with two M6 screws; the piston (29), moving in a cylinder with reciprocating motion, works on the principle of slot control with a constant beginning of pumping by the edge of the channel, made on its side.



2.121 Figure: INJECTION PUMP (POMPA WTRYSKOWA)

Piston stroke	8 mm
Piston diameter	7 mm
Number of sections	4
Distance of section axles	26 mm
Direction of rotation	right
Maximum speed	2200 rpm
Maximum injection pressure	60 Mpa
Maximum fuel delivery	80 mm^3
Unit fuel delivery	22 mm^3
Injection sequence	1-3-4-2
Setting values	See Table 2-52.

2.51 Table: PP.M.e INJECTION PUMP TECHNICAL CHARACTERISTICISTICS

Scope of action	**Speed, rpm**		**Number of injections**	**Dosage volume, cm3**
	engine	**injection pump**		
Starting dose	200	100	200	13...15
Operation of the equalizer	2500	1250	500	21,5...22,2
Rated dose	4200	2100	500	17,7...18,2
Operation of the speed controller:				
- inception	4280...4320	2140...2160	Time of dosage decrease	
- demise	4720	2360	End of dosage	

2.52 Table: REFERENCE VALUES OF PP4M7P1e3097 INJECTION PUMP

When the piston is moving in the direction of internal turning (ZW), the cylinder is filled with fuel through the inlet hole in the cylinder wall and connects the space above the piston with the supply

chamber. During the upward movement of the piston, after the so-called initial stroke, the piston is closed by the control edge of the supply opening and the start of the fuel delivery process. This position of the piston is called the Geometric Start of Pumping (GPT). Further movement of the piston in the direction of external rotation (ZZ) causes compression of the cut-off fuel dose, lifting up of the outlet valve plug (35) and directing the fuel to the stub (34) of the high-pressure hose connecting the pump with the injector. The pumping process stops when the overflow opening edge is exposed by the piston control edge, as the space above the piston is connected to the supply hole via the central channel in the piston and the aforementioned channel on the side of the piston.

During the further pressing phase, up to ZZ, the fuel is pumped into the supply manifold and the valve plug settles in its seat, first cutting off the connection between the cylinder and then extracting from the water a specific volume of fuel called the "relief volume". This phenomenon causes a rapid pressure drop in the high-pressure line and closing of the injector nozzle until the start of the blunt injection.

The filling stroke is carried out only by applying pressure to the expanding springs (40). The operating stroke, with the simultaneous tensioning of the replaced springs, is forced by the camshaft hump (42) via the roller tappet (41). The fuel delivery is determined by turning (within ± 5°) the adjusting sleeve (39) and the piston (29) coupled to it. The bushings of all discharge sections are connected together by a pinion (30), which is led into the control space and connected to the control lever by a lever mechanism of the speed controller. The alignment of the control sleeves in the individual sections is achieved by rotating the cylinders around their axes and locking them.

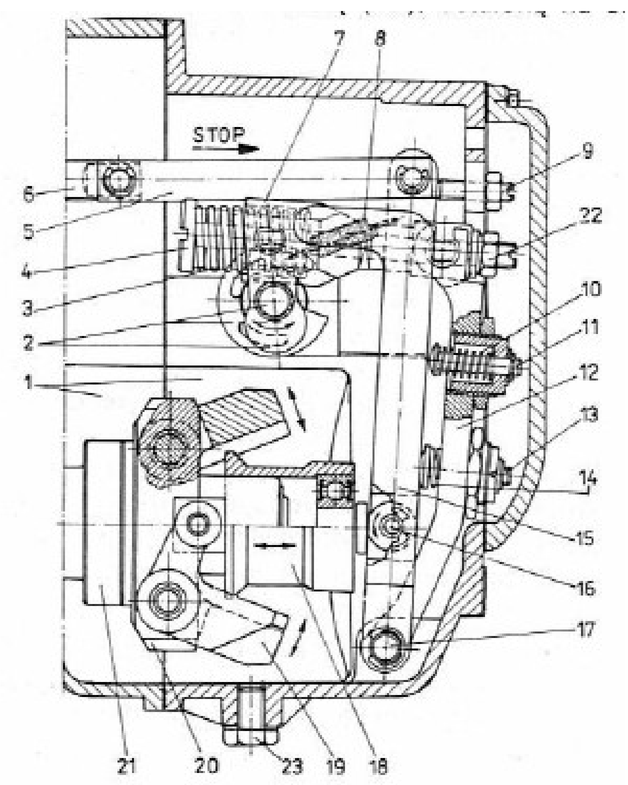
The GPT is determined by the selection of the lower spring cup (27) and the lower adjustment decks (26) between the spring cup and the tappet. The lower bowls are made in three basic dimensions, which make it possible to determine the beginning of pressing at different distances from the piston face to the ZZ. The height of the mounted bowl is 2,0 mm for the PP4M7P1e3097 pump.

The pump is driven as described in section 2.3.7. The pipes are used to connect the pump to the fuel system of the vehicle (8,11). The pump lubrication system is integrated into the engine lubrication system.

■ The two-range centrifugal control RN1M 350/2100 (Fig. 2. 122), driven by a drive shaft (21) from the cam shaft of the injection pump, consists of the hub (20) with two bulbs (19) pendulumly mounted inside it, which act on the sliding sleeve (18) through a bearing with a thrust pin in constant contact with the roller (16), fixed on the axis of the free lever (15).

This lever is connected with the control sprocket (6) by a string (5). The angular lever (12), supported by the lower end on the common axle (17) with the free lever, is coupled with the eccentric lever (2) via a pin (4) which is pinned to the upper forks of the lever, spring (3) and washer (7). The outer pivot of the eccentric lever has a fixed control lever (14, Fig. 2.121) connected by a drawbar with an accelerator pedal. The dosage corrector (13, 14 Fig. 2.122) and the automatic engine idling speed control, consisting of a bumper (11) and a spring (10), are mounted in the angle lever. A tension spring (8) is fitted between the upper end of the free lever and the axle of the eccentric lever for the starting dose of the fuel. The pin (4) is fitted with a compression

spring (3) leaning against its head by one end, and against the bottom of the inner socket (7) by the other end.



2.122 Figure: TWO-RANGE SPEED CONTROLLER (DWUZAKRESOWY REGULATOR PRĘDKOŚCI OBROTOWEJ)

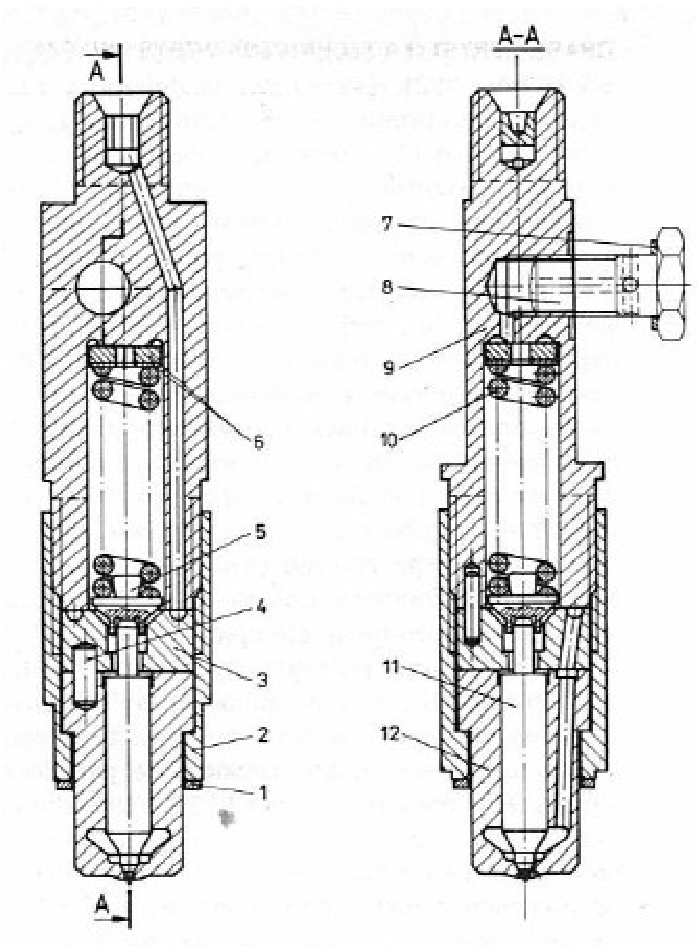
1 - housing, 2 - eccentric lever, 3 - motor speed control spring, 4 - pin, 5 - cable. 6 - control sprocket, 7 - control sprocket. 8 - spring of starting dose, 9 - adjusting screw (bumper), 10 - spring of idling speed control. 11 idle bumper, 12 angular lever, 13 equalizer pin, 14 equalizer spring, 15 freewheel, 16 roller, 17 axis. 18 - Sliding sleeve. 19 - weights, 20 - hub, 21 - carrier, 22 - nut, 23 - oil drain plug

1 - obudowa, 2 - dźwignia mimośrodowa, 3 - sprężyna regulacji prędkości znamionowej silnika, 4 - sworzeń, 5 - cięgno. 6 - zębatka sterująca, 7 - wodzik. 8 - sprężyna dawki rozruchowej, 9 - wkręt regulacyjny (zderzak), 10 - sprężyna regulacji prędkości obrotowej biegu jałowego. 11 - zderzak regulacji prędkości obrotowej biegu jałowego, 12 - dźwignia kątowa, 13 - sworzeń korektora, 14 - sprężyna korektora, 15 - dźwignia swobodna, 16 - rolka, 17 - oś. 18 - tuleja przesuwna. 19 - ciężarki, 20 - piasta, 21 - zabierak, 22 - nakrętka, 23 - korek spustowy oleju

During engine starting, the control lever is turned to the position where its bumper (15, Fig. 2.121) is held against the stop (13) screwed into the pump casing. An eccentric lever coupled kinematically to the control lever moves the angle lever (12, Fig. 2.122) to the extreme front position. In this position, the spring of the starting dose (8), supported by the spring action of the idling gear (10), moves the free lever and with it the control sprocket (6) into the maximum dosage position, i.e. to rest against the sprocket face against the adjustable bumper (6, Fig. 2.121). Correct engine starting is possible. Release of the accelerator pedal to allow the engine to idle shall bring the control lever back to its rear position as specified by the adjusting screw (16) of the ASLF unit. Reverse movement of the control lever moves the angle lever back to its rear position. The freehand lever follows the lever as a result of the centrifugal force of the rotating control weights. The relatively low centrifugal force (idling speed approximately 700 rpm) is compensated in this position by the spring forces of the bumper (11, Fig. 2.122). From this moment on, the controller automatically increases or decreases the injection pump dosage, opposing the changes in the engine speed caused by the momentary fluctuations in effective power. This operating state is the first range of motor speed control. It is increased from idle to rated power by increasing the fuel dosage (driver presses the accelerator pedal). The control lever via eccentric lever, rod, spring and pin (4) moves the angle lever (12) in the direction of the front position. The angle lever (13, 14) presses on the free lever (15) via the equalizer. The equilibrium state in each intermediate position, until the nominal power turns, is achieved by balancing the centrifugal force of the weights rotating at increasing speed with the forces of the equalizer spring and the increasing spring tension (3).

When the motor exceeds the rated power speed (4200 rpm), the centrifugal force increases to a value that violates the described equilibrium; the spring is deflected (3) and the angular lever is retracted (with the control lever in the same position) to the rear end position. The released release lever also retracts by moving the control sprocket to the "STOP" position. This is the second range of motor speed control.

The 'STOP' device, mounted on the adjuster cover (Fig. 2.121), is used for switching off the engine and is controlled by a flexible drawstring, which is led to the permanent hood of the engine in the driver's cab. Its correct use boils down to pulling the tendon handle towards each other, with the accelerator pedal being slightly pressed. The release of the control lever (14, Fig. 2.121) moves the control lever to the rear end position and the control sprocket to the "STOP" position, moving it back out of the idle speed setting position. The lever mechanism of the regulator is lubricated with engine oil. This circuit is integrated in the lubrication system of the injection pump and is connected to the engine lubrication system. The plug-in in and outlet openings are located on the controller housing and cover.



1,7 - seals,
2 - nozzle nut,
3 - insert,
4 - setting pin.
5 - lower spring bowl.
6 - adjusting washers,
8 - hollow screw,
9 - housing,
10 - firing pin return spring.
11 - needle.
12 - sprayer

1,7 - uszczelki,
2 - nakrętka rozpylacza,
3 - wkladka,
4 - kołek ustalający.
5 - dolna miseczka sprężyny.
6 - podkładki regulacyjne,
8 - śruba drążona,
9 - obudowa,
10 - sprężyna powrotna iglicy.
11 - iglica.
12 - rozpylacz

2.123 Figure: INJECTOR (WTRYSKIWACZ)

■ Universal injector with lower spring (Fig. 2.123) type WNS-13, whose characteristics are presented in Table 2-53, is built of three basic components:

- a housing with a nozzle fixing nut; the housing is equipped with a high-pressure hose connection nipple, a coupling and a hollow bolt for the overflow line and a clamp for fixing the injector to the head settling tank;

- the firing pin return spring, with adjustment washer to be fixed on it. the preload (determination of the required injection pressure);
- a PINTAUX suppository atomizer designed to atomize fuel in a swirl chamber through two channels: the main one in the firing pin's axis and the one inclined at an angle of 20° to the axis.

The letters and numbers used in the specification of the injector shall indicate:

- W - injector,
- N - universal fixing,
- S - diameter of spray flange (17.0 mm)
- 13 - distance in mm from the nut face to the stop face of the nozzle.

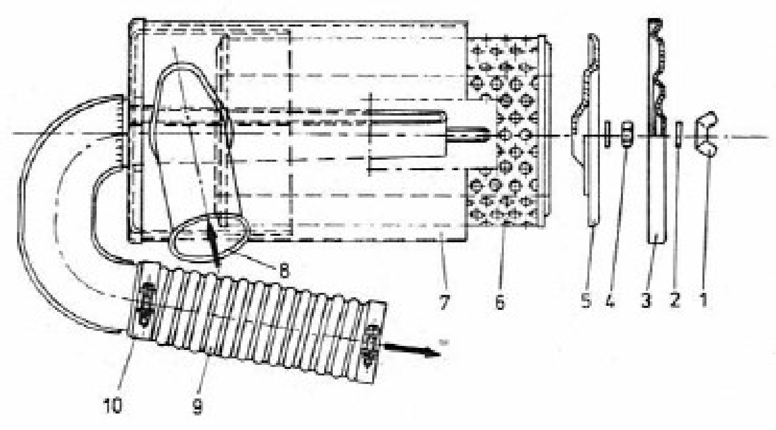
Injector	Tupe	WNS-13
	Attachment method	shackle
	- Shank diameter	21 mm
	Adjustment of injection pressure	by means of washers
	Maximum injection pressure	15 ± 0,5 MPa
Sprayer	Type	czopikowy PINTAUX
	Coding	DSZOO.W1 (WZM) or BDNOSPC 6389 (CAV)
	Angle of spray	0°
	Throttling play/jump	3/0,21, μm/mm
	Needlestick	0,56 mm
	Diameter of suppository	1,0 mm
	Diameter of diagonal channel	2,0 mm
	Angle of inclination of the slanting channel	20°

2.53 Table: TECHNICAL CHARACTERISTICS OF THE INJECTOR (WTRYSKIWACZ) AND SPRAYER (ROZPYLACZ)

During the opening of the nozzle, from the moment of the firing pin's detachment from the adjacent area, the fuel is initially sprayed with an inclined channel into the hot stream of compressed air flowing in counter-flow, starting the combustion process. Injection and combustion of the basic fuel dose by the main outlet channel takes place only after the gland's edge, which is the finished cone of the firing pin, has been removed from it.

Fuel injected from the swirl chamber through an inclined channel significantly shortens the ignition delay. Correctly adjusted injection timing is 12° before external return (ZZ) of the piston. The injector is fixed in the head socket by means of a clamp and two stud bolts with M8 nuts, between the injector and the thermal shield (4, fig. 2.100) a copper gasket is mounted (24, fig. 2.116), and me. between the nozzle and the cover - a sheet steel gasket (25, Fig. 2.116), both for single use.

■ The high-pressure hoses (10, Fig. 2.121) connecting the discharge sections of the injection pump with the injectors are seamless, thick-walled tubes (6x2mm) of equal length 312mm. They are fastened with M12x1,5 nuts through washers and sealed on cones with an apex angle of 58 ± 1°.



1,4 - nuts, 2 - washer, 3 - filter cover, 5 - filter insert cover, 6 - filter insert, 7 - filter housing, 8 - air inlet, 9 - flexible hose, 10 - clamping band

1,4 - nakrętki, 2 - podkladka, 3 - pokrywa filtru, 5 - pokrywa wkładu filtracyjnego, 6 - wklad filtracyjny, 7 - obudowa filtru, 8 - wlot powietrza, 9- przewód elastyczny, 10 - opaska zaciskowa

2.124 Figure: AIR FILTER

■ The air filter (Fig. 2.124) is dry, with replaceable filter element, attached to the front baffle of the driver's cab. Consists of a double tube (9), a filter insert (8) and two covers (4 and 7) fitted with nuts (2 and 6).

■ The filter insert in the form of a cylinder with an external diameter of 138 mm and an internal diameter of 83 mm is made of folded folding filter paper. The air drawn in by the tangential connection to the housing wall is guided by a steel wire reinforced duct (10) to the motor suction pipe.

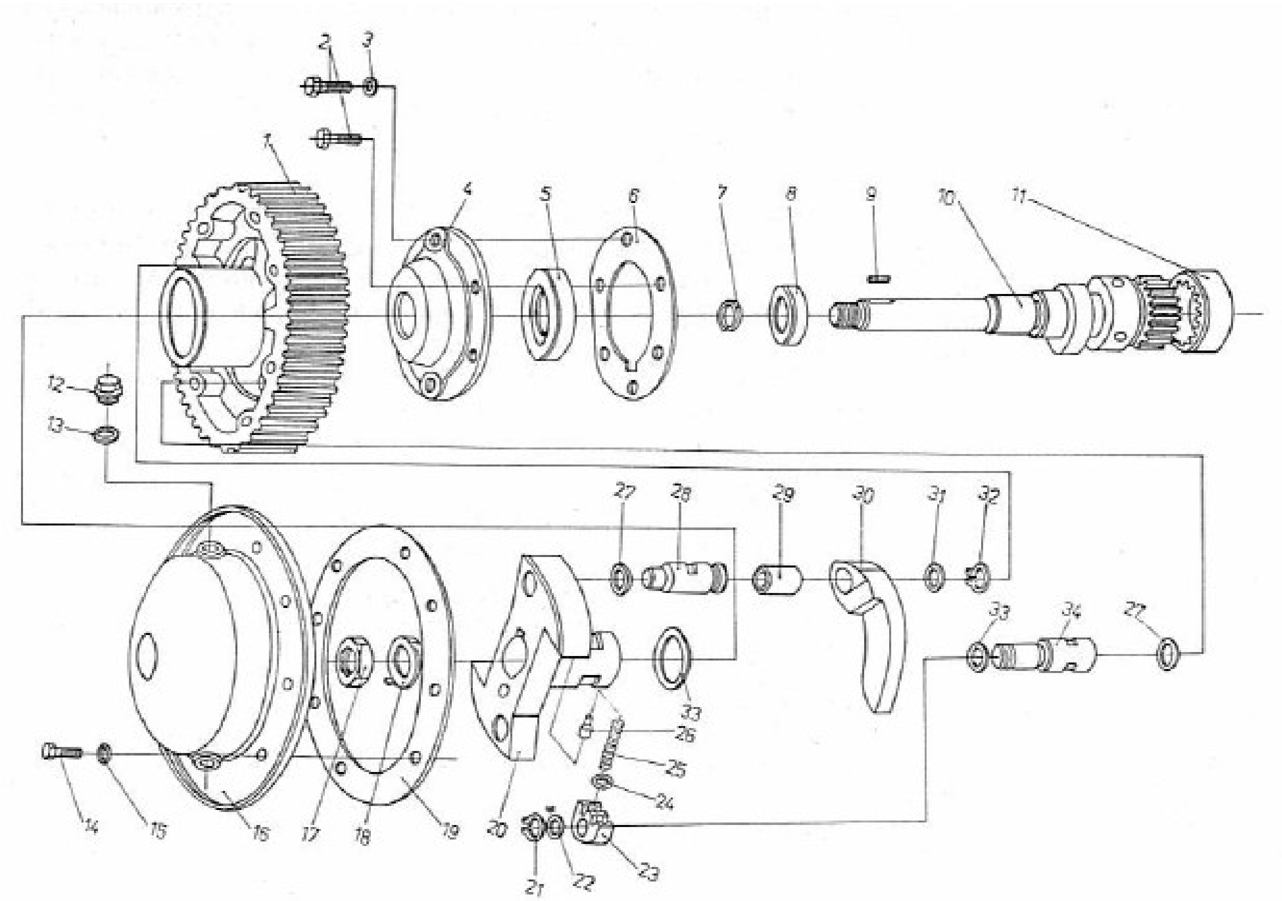
■ The motor suction line is an aluminium alloy casting. The district inlet to the collecting chamber has a flange with an external diameter of 71 mm and an internal diameter of 63 mm. From this chamber, four arc-shaped addictions with a rectangular cross-section of 42 x 37 mm, spaced between the salts every 110 mm, direct the air into the cylinders. In the front part of the cable there is an inflow with a hole M16 x 1,5 to the mount of the connecting piece of the engine crankcase ventilation duct.

2.3.7 4C90 Injection pump drive and timing mechanism

The injection pump and timing mechanism are driven by a toothed belt drive (Fig. 2.125). As in the case of camshafts, the drive ratio is 1:2. the toothed belt drive wheel (pos. 2.126) is fixed on the front crankshaft journal. Its charactics are presented in Table 2-54.

■ The drive shaft of the injection pump (Fig. 2.127), which is supported by multiple functional brackets attached to the engine housing, has a cast iron gear mounted on its front journal (1, Fig. 2.125), the technical characteristics of which are shown in Table 2-55. This wheel has a built-in fuel injection timing adjuster, the design and operation of which are discussed later in this chapter. At the rear end of the shaft, there is an eccentric (3) drive for the supply pump and a toothed ring with outer gearing (6) for connecting the cam shaft of the injection pump to the sprocket by means of a sleeve. The characteristics of gears and sleeves are given in Table 2-56, the position of the sleeve and the joined gears is ensured by a double tooth in the sleeve, and one expanded tooth notch in the

wheels. The shaft has internal oil channels, which are lubricated by bearing pivots (2 and 4) under pressure.



2.125 Figure: INJECTION PUMP DRIVE AND TIMING MECHANISM (NAPĘD POMPY WTRYSKOWEJ I MECHANIZMU ROZRZĄDU)

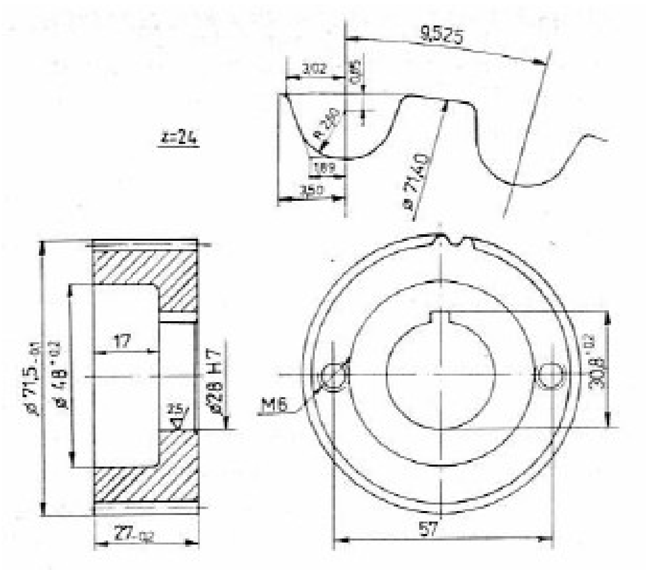
1 - toothed pulley, 2 - 14 - screws. 3, 15, 18, 22, 24, 27, 31, 33 - washers, 4 - cover, 5. 7. 13. 33 - sealing rings, 6, 19 - seals, 8 - ring (inner race of the sealant), 9 - key. 10 - drive shaft of injection pump, 11 - gear sleeve, 12 - filler and drain plug, 16 - adjuster cover for injection timing angle, 17 - nut, 20 - adjuster hub, 21,32 - spring rings, 23 - adjuster spring socket. 25 - spring, 26 - pin, 28. 34 - pin, 29 - bearing sleeve. 30 - weight of injection angle adjuster

1 - zębate koło pasowe, 2. 14 - śruby. 3, 15, 18, 22, 24, 27, 31, 33 - podkładki, 4 - pokrywa, 5. 7. 13. 33 - pierścienie uszczelniające, 6, 19 - uszczelki, 8 - pierścień (bieżnia wewnętrzna uszczelniacza), 9 - wpust. 10 - walek pędny pompy wtryskowej, 11 - tuleja zębata, 12 - korek wlewowy i spustowy, 16 - pokrywa przestawiacza kata wyprzedzenia wtrysku, 17 - nakrętka, 20 - piasta przestawiacza, 21,32 - pierścienie sprężyste, 23 - gniazdo sprężyn przestawiacza. 25 - sprężyna, 26 - kołek, 28. 34 - sworznie, 29 - tulejka łożyskowa. 30 - ciężarek przestawiacza kąta wtrysku

Number of teeth	24
Tine shape	in accordance with GATES n° 939
Diameter of the indexing wheel	72,77 mm
Diameter of the vertex wheel	$71{,}5_{-0{,}1}$ mm
Wreath width	$27_{-0{,}2}$ mm

2.54 Table: TECHNICAL CHARACTERISTICS OF THE SPROCKET DRIVING THE INJECTION PUMP AND THE TIMING MECHANISM

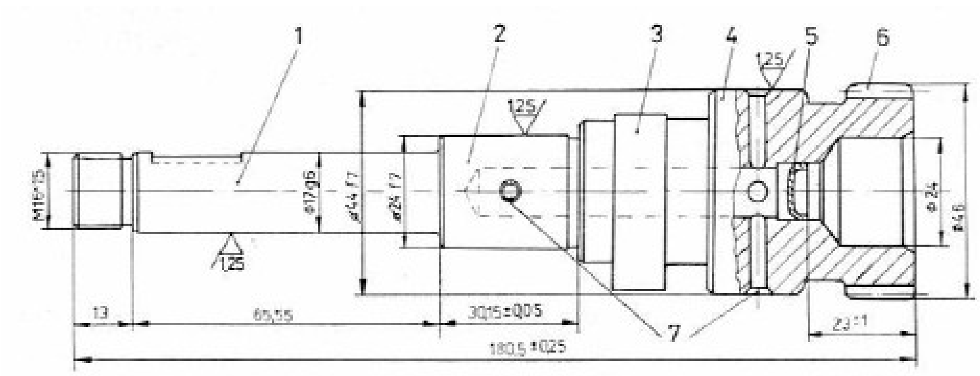
2.3.7 4C90 Injection pump drive and timing mechanism



2.126 Figure: DRIVE WHEEL FOR THE TIMING BELT OF THE INJECTION PUMP AND THE TIMING MECHANISM

Number of teeth	48
Tine shape	in accordance with GATES n° 939
Diameter of the indexing wheel	145,54 mm
Diameter of the vertex wheel	144,17 $^{+0,12}$ mm
Wreath width	
- camshaft sprockets	31 mm
- injection pump drive shaft wheels	34,8 mm

2.55 Table: TECHNICAL CHARACTERISTICS OF THE GEARS USED FOR THE DRIVE OF THE CAMSHAFT AND THE PEDAL SHAFT OF THE INJECTION PUMP



2.127 Figure: PEDAL SHAFT OF INJECTION PUMP (WAŁEK PEDNY POMPY WTRYSKOWEJ)

1 - Pin of the belt pulley of the injection timing adjuster, 2 - Pin of the front seat, 3 - Eccentric drive of the supply pump, 4 - Pin of the rear bearing, 5 - Cover cap, 6 - Gear ring. 7 - oil channels

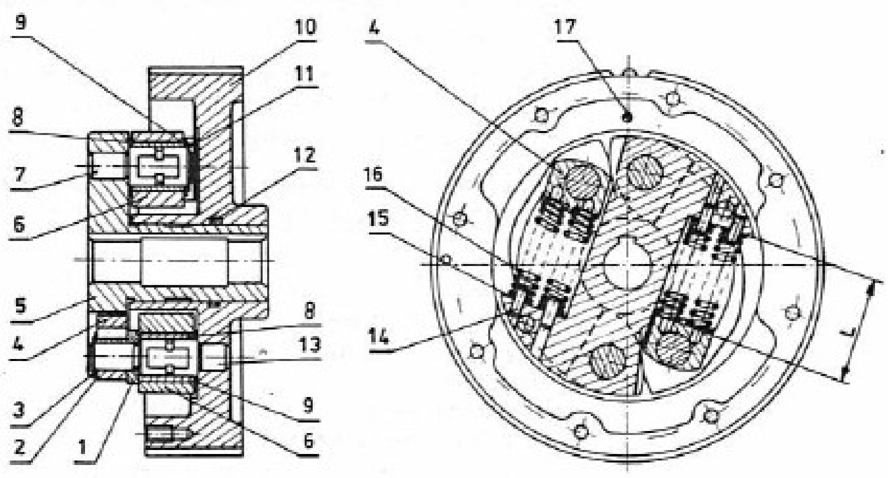
1 - czop koła pasowego przestawiacza kata wyprzedzenia wtrysku, 2 - czop łożyska przedniego, 3 - mimośród napędu pompy zasilającej, 4 - czop łożyska tylnego, 5 - zaślepka, 6- wieniec zębaty. 7 - kanaliki olejowe

2.3.7 4C90 Injection pump drive and timing mechanism

Definition	Gear wheels	Toothed bushing
Number of teeth Index diameter Dentition Wreath width	44 44 mm external 19 mm	44 44 mm internal 2 x 16 mm

2.56 Table: TECHNICAL CHARACTERISTICS OF THE GEARS OF THE INJECTION PUMP DRIVE

■ The injection pump bracket is a box-mounted aluminium alloy casting screwed through the POLONIT PP gasket to the left wall of the engine hull. In the central part there are two sockets for fixing the drive shaft of the injection pump: the front ones with a diameter of $32^{+0.025}$ mm and the rear ones with a diameter of $44^{+0.025}$ mm. The flange on the rear wall for mounting the injection pump shall have a hole in the centre of the seats of $68^{+0,045}$ mm diameter and holes M10 spaced 105 ± 0,15 mm in diameter for the fixing bolts. The window for the passage of the lever driving the supply pump shall be 26 x 36,5 mm.



2.128 Figure: ANGLE ADJUSTER FOR INJECTION TIMING (PRZESTAWIACZ KATA WYPRZEDZENIA WTRYSKU)

1,2,9,15 - washers, 3. 11 - spring rings. 4 - spring socket, 5 - hub. 6 - weights. 7. 13 Pins, 8 Bed Bushings, 10 Graded V-belt Wheel, 12 Gasket, 14 Catkins, 16 Spring, 17 Setting Sign, L- Installation length of springs.

1,2,9,15 - podkładki, 3. 11 - pierścienie sprężyste. 4 - gniazdo sprężyn, 5 - piasta. 6 - ciężarki. 7. 13 - sworznie, 8 - tulejka lożyskowa, 10 - zebate kolo pasowe, 12 - uszczelka, 14 - kotek, 16 - sprężyna, 17 - znak ustawczy, L- długość montażowa sprężyn

The P.P-8.2 full-flow engine oil filter screw-on socket is made in the upper wall of the bracket and has a stop flange with an external diameter of 76 mm and a central socket for the M18 x 1,5 filter adaptor.

■ The automatic pre-injection timing adjuster (Fig. 2.128) is a centrifugal interlocking controller for the transmission of the drive from the toothed pulley (10) to the drive shaft of the injection pump via the wedged hub (5), allowing the camshaft of the injection pump to be adjusted automatically in relation to the wheel (10) while the engine is running.

The weight pairs (6), which are mounted on two pins (7) in the hub (5) and on two pins (13) in the wheel (10), rotate at the wheel speed (10). The weight ends on the bearing side of the slide sleeves (9) are sections of the side of the cylinder with the axis offset eccentrically to the axis of the slide seat. The pairs of cooperating weights come into contact with such shaped surfaces of the ends under the influence of initial tension of compression springs (16).

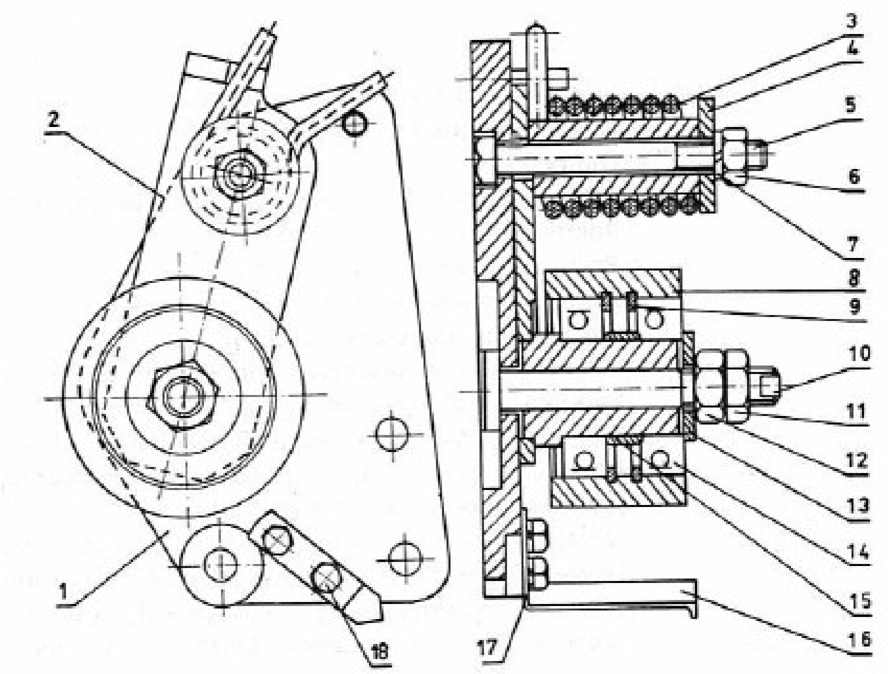
When the speed increases, the weights swing out due to centrifugal forces. The rotating eccentric ends of the weights cause mutual movement of the pins on which they are mounted, and thus

angular adjustment of the hub to the wheel (reduction of dimension "L" in Fig. 2.128). The centrifugal forces causing the mentioned torque are balanced by the spring force (16).

Wire diameter	2,5 mm
Number of active coils	7
Total number of reels	13
Direction of retraction	right
Preload (at spring height 36 mm)	100,6...138,6 N
Maximum load (at spring height 34 mm)	309,9...407,9 N

2.57 Table: SPRING CHARACTERISTIC OF INJECTION TIMING ADJUSTER

Table 2-57 shows the characteristics of the springs of the adjuster. The angular operating range of the injection angle adjuster is 12° of the crankshaft rotation of the engine. The adjuster operates in oil filling the front cover (16, Fig. 2.125). The cover has a window on the outer flange as a setting sign (dot) made on the drive wheel of the injection pump shaft.



1 - bracket, 2 - tensioner lever. 3 - spring, 4. 7. 13, 17 - washers, 5.10.18 - bolts. 6. 11, 12 - nuts, 8 - tensioner roller, 9 - circlip, 14 - bearing, 15 - spacer ring. 16 - indicator for setting the start of fuel delivery

1 - wspornik, 2 - dźwignia napinacza. 3 - sprężyna, 4. 7. 13, 17 - podkładki, 5.10.18 - sruby. 6. 11, 12 - nakrętki, 8- rolka napinacza, 9 - pierścień osadczy, 14 - łożysko, 15 - pierścień dystansowy. 16 - wskaźnik do ustawiania początku tłoczenia paliwa

2.129 Figure: TENSIONER FOR THE DRIVE BELT OF THE INJECTION PUMP AND THE TIMING MECHANISM

■ The timing belt tensioner (Fig. 2.129) for the injection pump drive and the timing mechanism is attached to the front wall of the engine hull. On the screw (5) of the support, the lever (2) with its bearing roller (8) is mounted pendulumly. The lever is tensioned by a spring (3) made of 5 mm diameter wire (the torque at a 75° angle of rotation shall be 11,8 ±1 N·m).

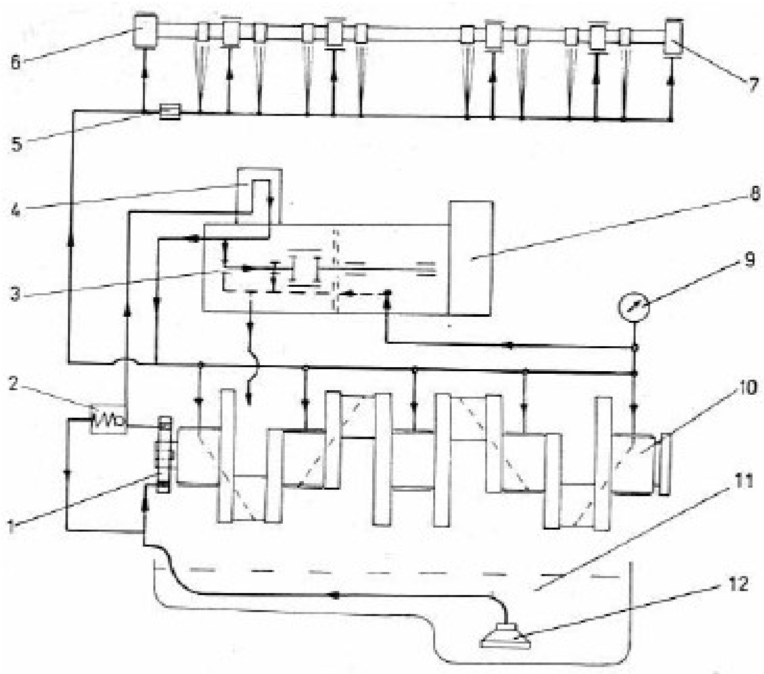
■ The 25 mm wide toothed belt, with the meaning of B131N17Gx, is covered by double-sided plastic sheaths. The correct belt deflection measured between the injection pump drive wheel and the camshaft drive wheel is 5 mm at a load of 11, 8...12,7 N.

2.3.8 4C90 Lubrication and ventilation system

The 4C90 engine uses a pressure-spray lubrication system (diagram in Figure 2.130) in which it is lubricated:

- under pressure are greased: main and crankshaft bearings of crankshaft, camshaft bearings, bearings of drive shaft of injection pump, camshaft bearings of injection pump, camshaft camshaft (spraying);
- splash is lubricated by: cylinder bushing arrangement, pistons, piston pins and valve levers.

The basic components of the system are the oil sump, the dragon and overflow valve oil pump, oil ducts and pipes, and the oil filter and pressure sensor.



2.130 Figure: DIAGRAM OF 4C90 ENGINE LUBRICATION SYSTEM

1 - rotary oil pump, 2 - bypass valve, 3 - drive bracket for injection pump. 4 - full flow oil filter, 5 - nozzle, 6 - camshaft, 7 - vacuum pump, 8 - injection pump, 9 - oil pressure sensor, 10 - crankshaft, 11 - oil sump, 12 - oil pump dragon

1 - wirnikowa pompa oleju, 2 - zawór przelewowy, 3 - wspornik napędu pompy wtryskowej. 4 - pełnoprzepływowy filtr oleju, 5 - dysza, 6 - wał rozrządu, 7 - pompa podciśnieniowa, 8 - pompa wtryskowa, 9 - czujnik ciśnienia oleju, 10 - wał korbowy, 11 - miska olejowa, 12 - smok pompy oleju

The oil filler, located on the cover of the head cap, is closed with a plug. The quantity of oil in the bowl is checked with a bar measure, on which the permissible levels are indicated (minimum and maximum). Nominal amount of oil is 6,0 dm^3 and the meter is finished with a handle enabling tight closing of the passage.

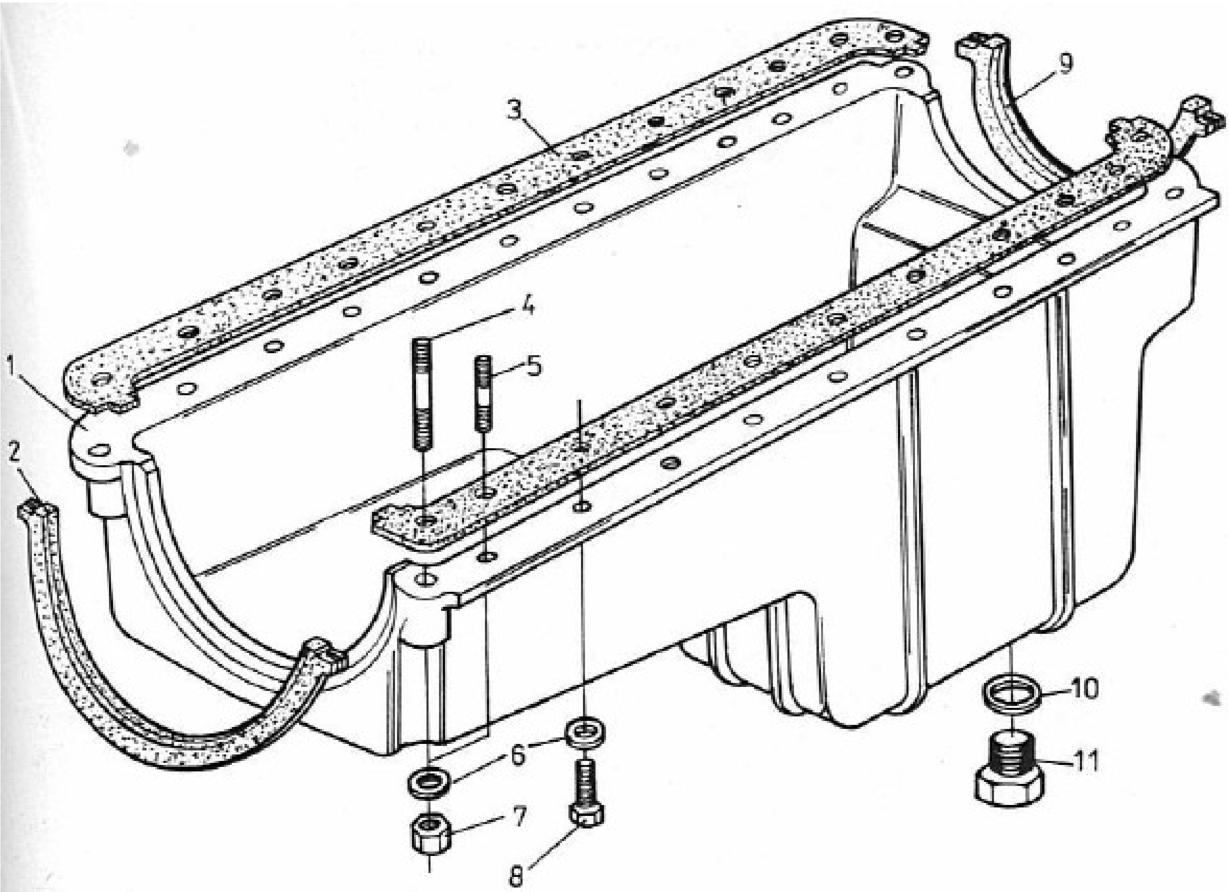
The oil circuit is forced by the crankshaft driven rotary pump. The oil sucked in by the dragon is pumped into the box bracket of the injection pump and the full flow oil filter P.P-8.2. The cleaned oil is then directed to the main oil line, 14 mm in diameter, in the engine hull and distributed through channels to the main bearings of the crankshaft and angular boreholes, 7 mm in diameter in its arms, to the crankshaft bearings. Part of the oil is directed from the main bus by the front vertical channel in the hull and the head to the base of the head, where it flows through longitudinal and transverse channels of 6 mm diameter to the camshaft bearings, and through channels of 1 mm diameter it is sprayed on its camshaft. At the front of the longitudinal channel, a dosing flow nozzle with filter is installed at the base of the head, which directs the excess oil to the most heavily loaded front bearing.

Other surfaces are lubricated with oil mist. This is caused by the oil being sprayed in the oil sump by moving engine parts, by the oil being pressed from bearings that are lubricated under pressure and collected by the piston scrapers and by the head falling off the base.

2.3.8 4C90 Lubrication and ventilation system

■ The oil pan (Fig. 2.131), which is a finned aluminium alloy casting with a wall thickness of 5 mm, is bolted to the engine hull using gaskets (3) with a thickness of 2 ± 0,15 mm, made of LANGITE SB 220S material. The rubber sealers (2 and 9) are mounted onconnecting the bowl with the edges of the oil pump housing and the flywheel housing. At the lowest point of the oil pocket there is an M22 x 1,5 threaded hole for the oil drain plug (11).

In newer engines, the oil sump is a sheet metal extrusion.



1 - oil sump, 2,9 - seals, 3 - seals, 4,5 - stud bolts, 6,10 - pads, 7 - nuts, 8 - bolts, 11 - oil drain plugs.

1 - miska olejowa, 2,9 - uszczelniacze, 3 - Uszczelka, 4, 5 - śruby dwustronne, 6,10 - podkladki, 7 - nakrętka, 8 - śruba, 11 - korek spustowy oleju

2.131 Figure: OIL SUMP (MISKA OLEJOWA)

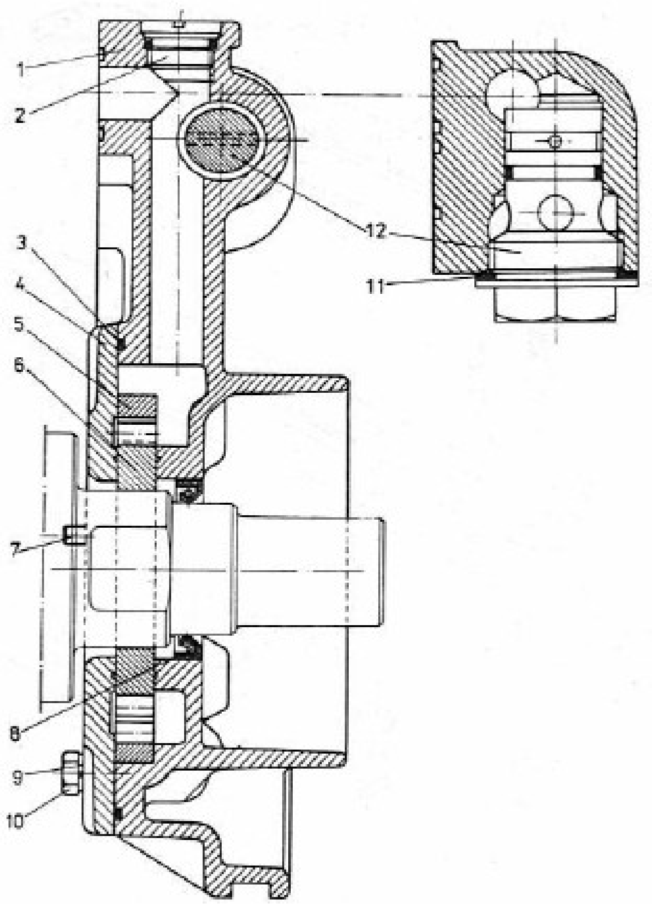
■ The rotary oil pump (Fig. 2.132) consists of an aluminium alloy housing, two impellers: one outer and one inner with a width of $10.5^{-0.020}_{-0.035}$ mm, a dragon and a piston bypass valve. The interlocked Distaloy AE impellers operate in a closed space with the pump casing and cover. The inner impeller is fixed on the crankshaft of the motor eccentrically in relation to the outer impeller. During operation, the oil is sucked into the interdental space and, as it is moved to the other side of the pump, extracted from it into the discharge channel. The pump characteristics are given in table 2-58.

An engine of an older design used a gear oil pump driven by a gear wheel from the drive shaft of the injection pump.

■ The dragon of the oil pump is equipped with a filter mesh to clean the pre-injected oil with a 28 mm diameter metal hose ending with a connection flange.

■ The bypass valve (Fig. 2.133) of the piston type reduces the pressure in the oil system. The 18 mm diameter piston (2) operates in the steel valve housing and is pressed by a 1.6 mm diameter spring (4) through a shim (3) to determine its preload. In the event of excessive pressure build-up in the system (e.g. dirty oil filter), the spring deflects and excess oil is directed to the suction side of the pump.

■ Full flow filter type PP-8.2 has a structure and works on the principle similar to the filter type PP-6.2 described in chapter 2.1.6. It has a larger active area of the filter element.



1 - casing, 2 - cork, 3 - 11 - gaskets, 4 - cover, 5 - external rotor, 6 - internal rotor, 7 - pin, 8 - seal, 9 - padding, 10 - screw, 12 - bypass valve.

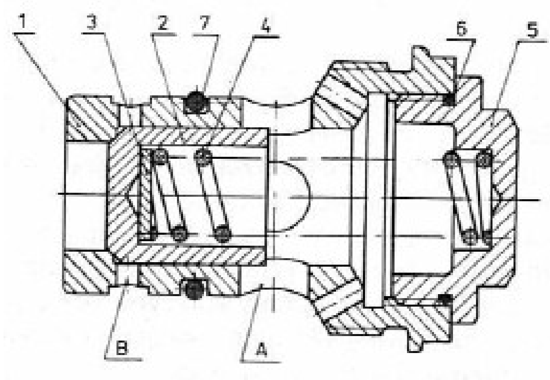
1 - obudowa, 2 - korek, 3. 11 - uszczelki, 4 - pokrywa, 5 - wirnik zewnętrzny, 6 - wirnik wewnętrzny, 7- kolek, 8 - uszczelniacz, 9 - podkladka, 10 - śruba, 12 - zawór przelewowy

2.132 Figure: ROTARY OIL PUMP (WIRNIKOWA POMPA OLEJU)

Number of tines of the outer rotor	9
Number of internal rotor tines	8
Eccentric displacement of the rotors	e = 3,5 mm
Interdental clearance at e = 3,5 mm	0,02...0,06 mm
Suction time at 200 rpm	max. 15 s
Volume output at 0,5 MPa pressure and speed:	
- 800 rpm	10 dm^3/min
- 4200 rpm	60 dm^3/min

2.58 Table: OIL PUMP CHARACTERISTICS

■ The oil pressure sensor is screwed directly into the main oil line. The crankcase chamber of the engine is ventilated by means of a flexible duct connecting the spigot on the cover of the head cap to the spigot on the inlet water of the engine.



1 - housing, 2 - piston, 3 - adjusting washer, 4 - spring, 5 - stopper, 6 - sealing, 7 - sealing, A - B - overflow holes.

1 - obudowa, 2 - tloczek, 3 - podkładka regulacyjna, 4 - sprężyna 5 - korek, 6, 7- uszczelniacze, A B - otwory przelewowe

2.133 Figure: BYPASS VALVE (ZAWÓR PRZELEWOWY)

2.3.9 4C90 Cooling system

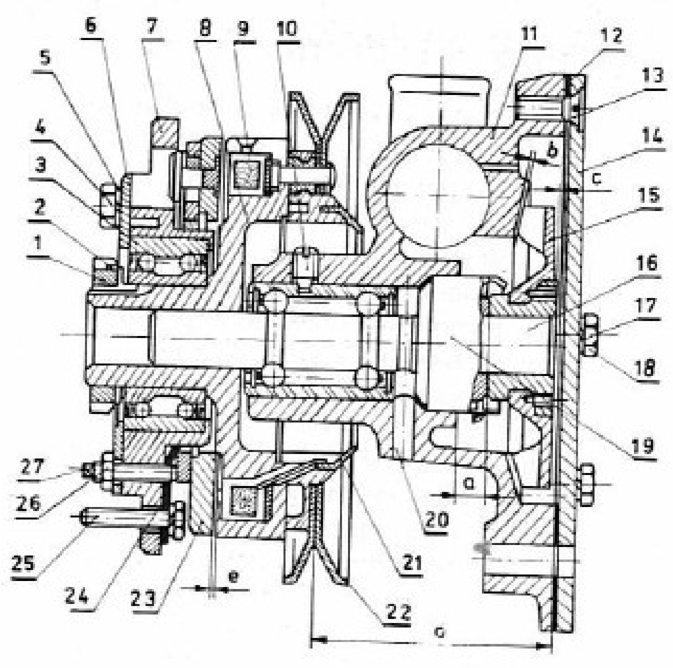
The 4090 engine has a closed cooling system with forced coolant circulation. It consists of a radiator with equalisation tank, a pump with an electromagnetic clutch fan, a thermostat and external ducts and internal ducts in the hull and the engine head. The system shall be filled with coolant via the radiator filler neck and the filler neck of the equalisation tank such that the level of the filler neck does not exceed the 'MAX' mark on the front face of the equalisation tank. The radiator throat and the filling opening of the equalising tank shall be closed with the plugs described in Section 2.1.7.

Liquid circulation depends on motor temperature. When the engine is cold, the liquid circulates in a so-called small circuit without a radiator. The pump conveys the coolant to the hull via a 40 mm diameter inlet window, from where it flows through the openings on the halfhead to the head, and returns from the thermostat casing (outlet before the thermostat valve) to the pump's suction line for recirculation. When the temperature of the liquid rises to 80...84°C, the thermostat valve in the housing on the motor head starts to open and the liquid starts to circulate in the so-called large circuit. It then flows through a rubber pipe to the upper tank of the radiator, flows down a core of pipes to the lower tank and is cooled by the pump and pressed into the channels in the hull and in the engine head. When the temperature rises to 96°C, the thermostat opens fully (valve plug rises to 9 ± 1.5 mm); at 87°C, the thermal sensor, screwed into the upper tank of the radiator, switches on the electromagnetic clutch of the cooling fan, which operates until the temperature of the liquid falls below 82°C again. When the temperature of the liquid rises to boiling point, at an excess pressure of 49,0 kPa, the outlet valve (7, Fig. 2.40) of the condenser cap opens, through which the vapour of the liquid and partly the liquid itself flows into the equalisation tank. When the engine cools down, the system generates a vacuum which, when it reaches 19.6 kPa, opens the non-return valve (8, Fig. 2.40) and the liquid from the equalising tank is sucked back into the system. The pressure in this container shall be equalized, at atmospheric pressure, by the valve (2, Figure 2.39). Regardless of the described coolant circuits, there is also a cabin heating circuit which is operated by a separate valve. The operation of this system, which uses a hot liquid from the engine cooling system, is discussed in Section 6.

Two drain faucets are used to drain the cooling system: one in the lower tank of the radiator, the other in the lowest point of the cooling system of the hull on its left side (behind the injection pump).

■ The centrifugal pump of the cooling system rotor (Fig. 2.134) is attached to the front wall of the hull as an assembly unit consisting of a pump, a cover and an electromagnetic fan coupling. This is a modification of the pump used in the CB motor (see section 2.2.7). The main difference is that an additional electromagnetic coupling is installed on the fan hub. It consists of two components:

- the pulley (22) connected to the hub (8), in which the electromagnet (9) and the slip ring (21) connected to the power supply brush are placed (the slip ring is isolated from the pulley),
- the fan hub (7) located on the belt pulley hub (8) and the disk (23) connected to the fan hub by three flat springs (24). This disk is the jumper of the electromagnet. When the solenoid coupling is switched off, the cooling pump drive pulley rotates independently of the fan mounted on the hub (7). When the temperature in the upper tank of the radiator rises to 87°C, the sensor placed in it switches the voltage on the windings of the electromagnet on. The disc (23) is coupled with the hub (8) and the hub (7) is rotated with the fan mounted on it. In order for the electromagnetic coupling to function properly, it is necessary to maintain a gap of 0.25...0.35 mm between the "e" and "0.25...0.35 mm". The slot is adjusted by screws (27). The design of the electromagnetic coupling is discussed in detail in chapter 7.



2.134 Figure: ENGINE COOLING SYSTEM PUMP

1,26 - nuts. 2,5,17 washers, 3 seal, 4, 18, 25, 27 bolts, 6 cover, 7 fan hub. 8 - pulley hub, 9 - electromagnet, 10, 13 - screws. 11 - Housing, 12 - Gasket, 14 - Pump cover, 15 - Rotor, 16 - Shaft, 19 - Gasket, 20 - Control hole, 21 - Slip ring, 22 - V-belt pulley, 23 - Disc (Jumper), 24 - Spring

1,26 - nakrętki. 2,5,17 - podkładki, 3 - fożysko, 4, 18, 25, 27 - Śruby, 6 - pokrywa, 7 – piasta wentylatora. 8 - piasta koła pasowego, 9 - elektromagnes, 10, 13 - wkręty. 11 - obudowa, 12 - uszczelka, 14 - pokrywa pompy, 15 - wirnik, 16 - wałek, 19 - uszczelniacz, 20 - otwór kontrolny, 21 - pierścień ślizgowy, 22 - koło pasowe, 23 - tarcza (zwora), 24 - sprężyna

■ The wax type thermostat is the same as for the CB motor (see section 2.2.7). Thermostat housing with. The cover, made of an aluminium alloy, is attached to the front of the engine head via a gasket with three M8 screws. In the lower wall of the casing, a 26 mm spigot is formed with an outside diameter of the so-called 'small circuit' of the coolant. The liquid temperature sensor,

screwed onto conical thread B-3/8", is connected to the indicator on the set of indicators in the driver's cab. A detailed description of the design and operation of the sensor and indicator is provided in Chapter 7.

■ The cooling pump, four-vane fan and alternator are driven by a 9.5 x 8 x 1025 mm V-belt from the crankshaft belt pulley of the engine. This wheel consists of a hub and a ring with a V-belt groove, between which there is a rubber insert. It acts as a vibration damper. The complete pulley is balanced to an accuracy of 0,00064 N·m. The correct belt tension, measured by its deflection at a contact pressure of approximately 50 N at half the distance between the crankshaft pulley and the alternator pulley, is 15 mm; it is adjusted by repositioning the alternator.

■ The four-row tube and belt-type radiator has a similar design to that of the S-21 engine radiator described in section 2.1.7. Its heat output has been increased to 49 kW due to the higher thermal load on the 4C90 engine by increasing the number of tubes and strips.

2.3.10 4C90 Exhaust system

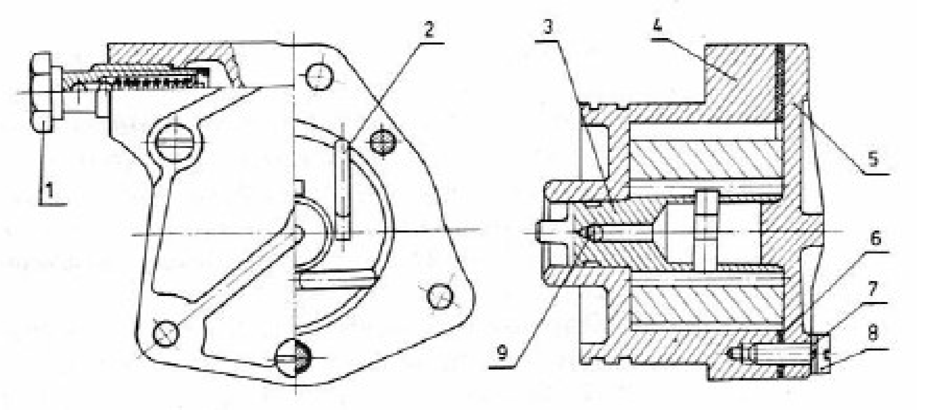
The exhaust system shall consist of an exhaust line, an exhaust pipe and a silencer.

■ The cast iron exhaust pipe has four branches with internal ducts that connect at the outlet to a 50 mm diameter collector pipe. The mounting flange, located at a 45° angle, has three M10 threaded holes and the exhaust and suction lines are bolted to the engine head via a common gasket. A thermal shield made of sheet steel is provided between the exhaust pipe and the starter.

■ The exhaust silencer shall be the same as that used for the CB engine exhaust system (see Chapter 2.2.8).

2.3.11 4C90 Vacuum pump

The vacuum pump (Fig. 2.135), which supplies the service braking system support, is a vane pump driven by a fin clutch from the camshaft. The technical characteristics of the pump are given in Table 2-59.



1 - non-return valve, 2 - rotor top 3 - rotor, 4 - housing, 5 - cover, 6 - seal, 7 - padding, 8 - screw, 9 - oil channel

1 - zawór zwrotny, 2 - topatka wirnika
3 - wirnik, 4 - obudowa, 5 - pokrywa, 6 - uszczelka, 7 – podkladka, 8- wkręt, 9 - kanal olejowy

2.135 Figure: VACUUM PUMP

The rotor (3), which is mounted in a housing (4) eccentrically, has four blades (2) fixed in motion. The rotor hub is hollow; it forms oil channels through which oil flows from the head base under pressure, pressing the blades against the housing cylinder. Rotation of the rotor creates a vacuum on the suction side which keeps the non-return valve (1) in the open position.

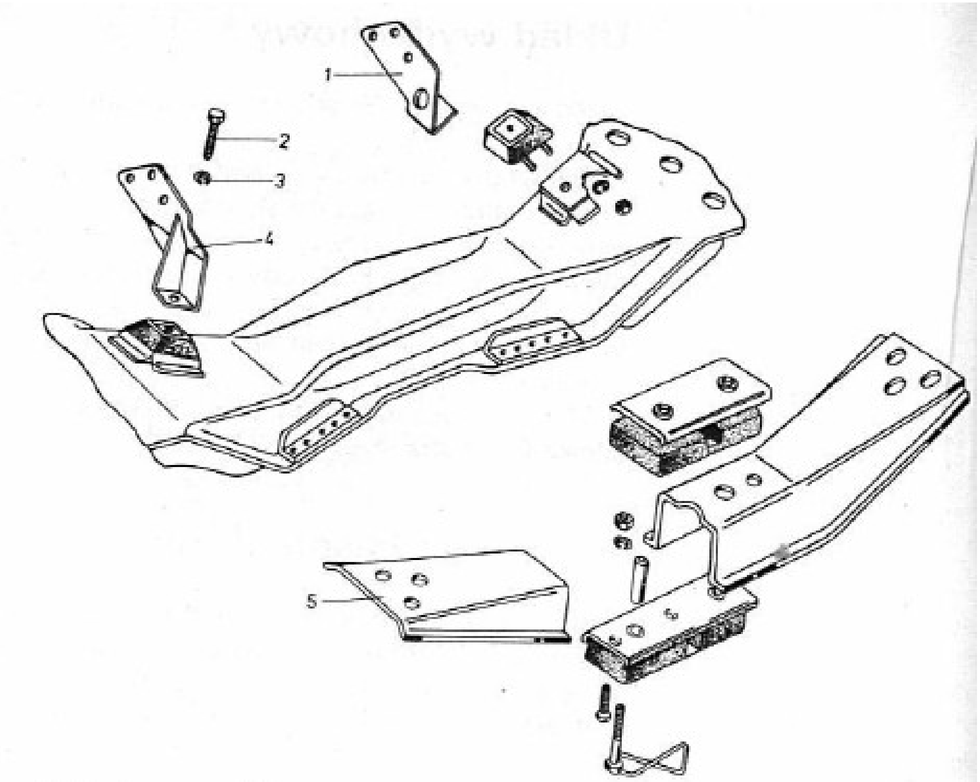
2.3.11 4C90 Vacuum pump

Speed	500 rpm	2100 rpm
Time for emptying the 1,4 dm^3 tank at a vacuum of 39 kPa to 78 kPa	max. 12 s	max. 4 s
Vacuum to be generated Supply oil pressure	min. 82 kPa 24...39 kPa	

2.59 Table: VACUUM PUMP CHARACTERISTICS

2.3.12 4C90 Suspension

The engine is suspended in the car frame (Fig. 2.136) at three points on the same rubber pad as the S-21 engine (see Chap. 2.1.9).



1 - right front bracket, 2 - screw, 3 - padding, 4 - left front bracket, 5 - rear engine mounting crossbar (for more information, see Fig. 2.47)

1 - wspornik przedni prawy, 2 - śruba, 3 - podkladka, 4 - wspornik przedni lewy, 5 - poprzeczka tylnego mocowania silnika (pozostałe elementy patrz rys. 2.47)

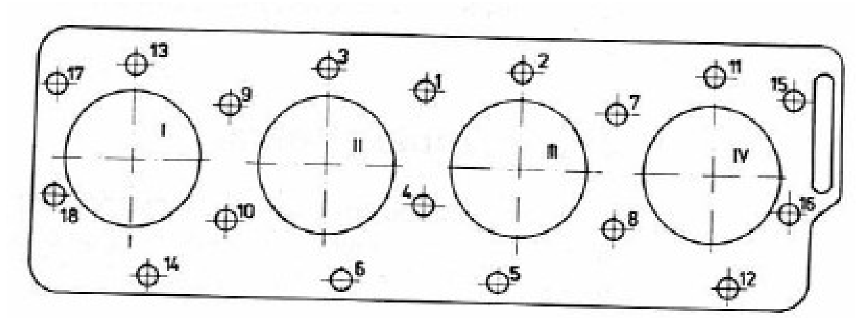
2.136 Figure: 4C90 ENGINE SUSPENSION

2.3.13 4C90 Maintenance

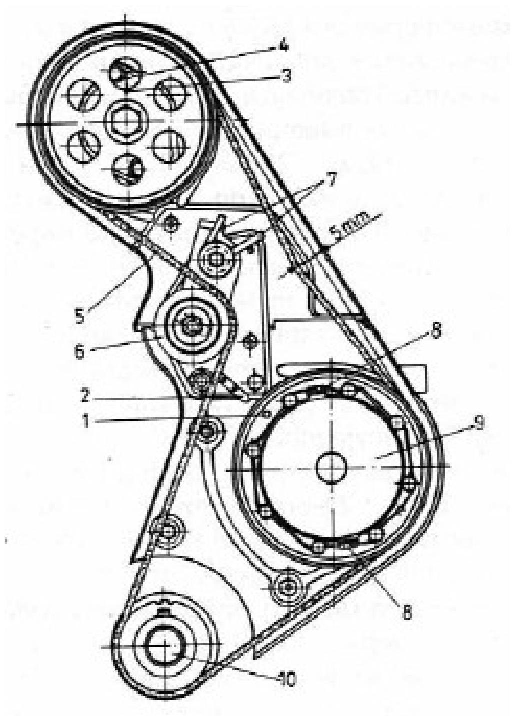
The 4C90 engine and its accessories are serviced at the same intervals as the S-21 engines and the following are basic differences in the scope and timing of maintenance and replacement of the engine oil (if there are differences, please refer to the Owner's Manual supplied with each purchased vehicle).

Operating the head is limited to tightening the screws and fastening nuts with the required torque. After the first 1500 ± 200 km (OTD), check with a torque wrench that the bolt nuts for head fixings are tightened in the order shown in Figure 2.137. The head nuts are tightened to a torque of 93...98 N.m. After the same run, the bolts and nuts for head cap fixtures must be tightened. For this purpose, the piston of the 1st cylinder must be set in the outer position (the ZZ mark on the

flywheel should coincide with the setting chart on the circumference of the wheel), after which it must be turned 90° to the left in order to avoid the possibility of breaking the valve levers. The tightening torque is 34...44 N·m.



2.137 Figure: 4C90 ENGINE - TIGHTENING SEQUENCE OF BOLT NUTS FOR HEAD FASTENING



2.138 Figure: ADJUSTMENT MARKS FOR THE CAMSHAFT AND INJECTION PUMP DRIVE SHAFT DRIVE WHEELS

1 - sign on the drive wheel of the injection pump shaft. 2 - sign (as an arrow) on the belt tensioner housing, 3 - sign on the camshaft, 4 - sign (as an arrow) on the head cap. 5 - toothed belt, 6 - tension pulley, 7 - toothed belt tensioner, 8 - oil filler and drain plugs from injection angle adjuster, 9 - injection angle adjuster, 10 - crankshaft drive wheel

1 - znak na kole napędowym wałka pompy wtryskowej. 2 - znak (w postaci strzałki) na obudowie napinacza pasa, 3 - znak na kole rozrządu, 4 - znak (w postaci rysy) na nasadzie głowicy. 5 - pas zębaty, 6 - rolka napinacza, 7 - napinacz pasa zębatego, 8 - korki wlewowy i spustowy oleju z przestawiacza kata wtrysku, 9- przestawiacz kąta wtrysku, 10 - koło napędzające na wale korbowym

The **timing system is operated** by regulating the valve lash adjustment and the timing belt adjustment and replacement of the timing belt of the timing belt drive. The valve lashings are adjusted by turning the spherical head screw (Fig. 2.116) after removing the cap cover from the head assembly until a 0,2 mm gap is created between the cam base and the valve lever (the clearance for the intake and exhaust valves is the same). The adjustment is carried out sequentially for cylinders 1-3-4-2 after each setting of the piston in the external turn. After adjustment, secure the screws with counter nuts. The adjustment is carried out every 27 000 km.

The **timing belts for camshaft drive and injection pump** must be replaced when the belt drive of the cooling system and alternator pumps and the front casing of the timing belt are removed (Fig. 2.138). Before this operation, the setting marks on the injection pump drive wheel (1) and on the

camshaft drive wheel (3) must be matched with the setting marks on the timing belt tensioner (2) and on the camshaft front bushing flange (4), with the GMP mark (ZZ) on the flywheel in front of the setting mark on the wheel housing. After releasing the lock nut and the nut fixing the tension pulley (11, 12, Fig. 2.129) and pulling it to the left, the belt can be removed. The new belt must first be fitted to the gear wheels and then to the tension pulley. The tensioner spring, when moving to the right, will cause the required belt tension. The correct belt deflection under a force of 11,8...12,7 N is 5 mm. The measurement shall be carried out at half the distance between the drive wheels of the injection pump shaft and the camshaft. Once this condition is met, tighten the nut and counter nut that secure the tension pulley. The belt tension must be adjusted every 27 000 km.

> It is essential to replace the timing belts after every 81,000 km or sooner if you notice any wear. If the belt breaks, the timing mechanism, and in extreme cases the crankshaft piston mechanism, could be damaged.

Supply system operation. The basic condition for the correct operation of the power supply system is to ensure purity of the fuel and its proper quality. Diesel fuel intended for high-speed, marked engines must be used for the propulsion of the engine:

- during the summer period - I Lś,
- in winter: MA-20 (solidification temperature -20°C) MA-35 (solidification temperature -35°C) or MA-50 (solidification temperature -50°C); the filter blockage temperatures are higher and higher respectively: -12°C, -20° C and -30° C, and they determine the right oil grade for the ambient temperature at which the vehicle is to be operated. The cleanliness of the diesel fuel must be taken care of in particular, as the tight fit of the cooperating parts in the pairs of precision and the small diameters of the ducts and nozzle holes easily cause their blockage or clogging, excluding them from operation. Fuel should be collected and poured in covered areas, protected from the weather and through funnels with gesture filter screens.

The fuel tank must not be emptied completely during operation. The tanks must be cleaned after every 27 000 km. For this purpose, after the fuel has been drained, the inside and the dragon are rinsed off with kerosene or pure diesel.

The fuel system shall be vented:

- when the engine is first started,
- after replacing fuel lines at low pressure,
- after replacing the injection pump, feed pump or fuel filter,
- after driving until the fuel supply in the tank is exhausted,
- before adjusting the fuel injection advance angle,

- after removing the play at the hose couplings and, if necessary, in the event of a leak in the system.

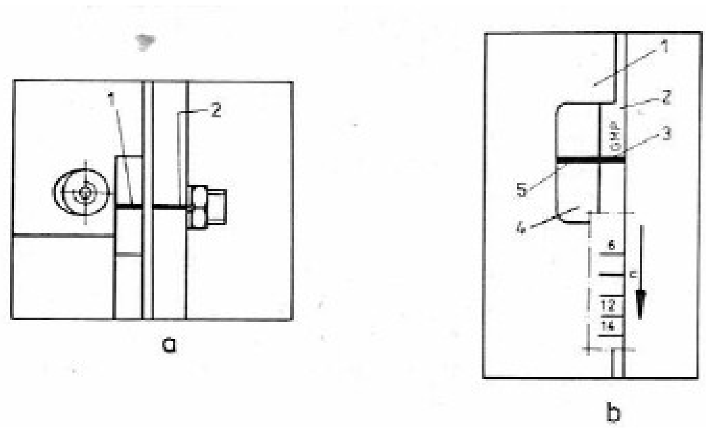
The fuel is pumped by means of the hand lever of the supply pump at the loosened screw of the fuel filter venting and the screw of the injection pump venting. As soon as there are no air bubbles at the fuel outlets, the screw on the fuel filter and then the screw on the injection pump are tightened first.

The **replacement of the fuel filter insert** consists in removing the screw (7, fig. 2.120), removing the cartridge (6), washing the casing (the settling tank), inserting a new cartridge and re-screwing the cover with the casing. The cartridge should be replaced every 18 000 km, and in the course of subsequent OTs the water should be drained from the settling tank through the valve located at the bottom of the cartridge.

Operation of injection pump and injectors. The injection pump does not require any maintenance other than the above mentioned venting. If the angle of the start of the pumping operation becomes unadjusted, loosen the nuts that hold the pump to the bracket and, by rotating around the horizontal axis, bring the pump to a position where the setting features on the pump flange and the bracket are in line (fig. 2.139) and the meniscus in the capillary screwed into the outlet of the pumping section vibrates (rises).

The engine idling is adjusted by turning the screw (16, Fig. 2.121) until the speed of 700 rpm is reached and its position is determined by the nut (17, Fig. 2.121). Changing the settings of the automatic idling governor (10 and 11, Fig. 2.122) is not part of the driver's maintenance. Injectors are subject to periodic control of the injection pressure. The first one is carried out after the first 1500 ± 200 km and the second one every 27 000 km. The removed injector should be cleaned of carbon deposits with a copper brush and washed in diesel oil. Injection pressure and fuel spray quality are checked on a special test bench. The correct pressure is 13.7...15.2 MPa. The adjustment is made by selecting the washers for the return spring (fig. 2.123).

The quality of the fuel spray shall be checked visually. In the first phase of firing pin opening fuel should flow out (shake) through oblique hole with a longer and wider jet than for the main channel, which is connected to work in the second phase of injection. Streams shall have no streaks or zones of unsprayed fuel. The start and end of the injection process is characterised by a subdued sound. No moisture or oil droplets must be present at the end of the sprayer.



2.139 Figure: SETTING MARKS FOR SETTING THE START OF FUEL DELIVERY BY THE INJECTION PUMP

a - characters on the bracket (1) and the injection pump (2), b - characters on the flywheel and housing, 1 - the flywheel housing. 2 flywheels, 3, 5 - external turn setting diagrams (GMP), 4 - sight glass

a - znaki na wsporniku (1) i pompie wtryskowej (2), b - znaki na kole zamachowym i obudowie, 1 - obudowa koła zamachowego. 2- koło zamachowe, 3, 5 - rysy ustawcze zwrotu zewnętrznego (GMP), 4 - wziernik

The **operation of both high and low pressure fuel lines** is based on the removal of noticed leaks on the couplings. Tightening the fixing nuts on the high pressure hoses is checked every 18 000 km with a torque of 25^{+5} N-m.

The **operation of the supply pump** is limited to periodical cleaning of the settling tank in kerosene or clean diesel oil and drying in compressed air. Cleaning is carried out every 9000 km.

The **air filter is operated** by periodically blowing the paper filter element with compressed air and replacing it every 9000 km.

The **arrangement of the gear on the drive shaft of the injection pump** is discussed in the section on the operation of the camshaft.

The **injection timing adjuster** is maintenance-free, except for periodic oil changes. The oil is changed every 54,000 km.

The **operation of the lubrication system** is the same as for the S-21 engine (section 2.1.10). Change engine oil and oil filter every 18 000 km. The oil change in the injection timing adjuster consists of draining the used oil and filling it with fresh oil (0,2 dm^3). Drain plugs and filler plugs are shown in Figure 2.125. The drain plugs and filler plugs are not included in the scope of this Annex.

The **cooling system is operated** in the same way as the S-21 motor (section 2.1.10), paying attention to the belt tension (fig. 2.94), the deflection of which, measured halfway between the water pump pulley and the alternator pulley, should be 15 mm at a tension of 50 N, and to the correct operation of the thermostat:

- valve opening temperature 80...84° C,
- temperature of complete opening of the valve 96° C,
- electromagnetic clutch sensor (switch-on temperature 87° C).

Failure to observe the above parameters causes the motor to overheat (indication of the temperature indicator in the red field).

V-belt tension is checked every 9,000 km and the operation of the electromagnetic coupling and the tightness of the cooling pump every 27,000 km.

2.3.14 4C90 Repairs

A list of typical symptoms and the most common operating conditions of the engine are given in Table 2-60, as well as information on how to remove the detected defects. Repairs on return to the engine shall be of full technical performance, as in the case of the S-21 spark-ignition engine, and shall be divided into current (NB), intermediate (NS) and overhaul (NG) repairs and shall be carried out in the planned maintenance management during the following periods:

- NB - after each 75,000 km mileage,
- NS - 150,000 km each,
- NG - 250,000...300,000 km each.

The motor NB includes:

- external visual inspection,
- tighten bolts and nuts,
- inspection and adjustment of injectors,
- check the starter and alternator,
- checking the operating parameters of the motor.

The engine NS includes:

- inspection and repair of major components,
- check the valves for leaks and remove any leaks,
- changing the piston rings in case of excessive oil wear.

The engine NG includes:

- dismantling of the engine onto assemblies, subassemblies and parts,
- replacement of cylinder liners and pistons,
- verification and possible grinding of the crankshaft pivots to the next sub-dimension or replacement of the crankshaft with a new one,
- replacement of the main and crankshafts,
- replacement of seals and sealing rings,
- verification of other parts and components and their possible repair or replacement,
- engine mounting and adjustment on the test bench.

The following symptoms are the basis for classifying an engine as NG:

- Excessive loss of lubricating oil pressure: less than 49 kPa at engine idling speed and less than 290 kPa at maximum engine idling speed,

- lubricating oil consumption exceeding 1,5% of the quantity of fuel used,
- the compression pressure when turning the crankshaft with the starter (200...250 rpm) is less than 2,45 MPa and the difference for the individual cylinders is more than 0,5 MPa,
- the fuel consumption is 10% higher than the fuel consumption control specified in Table 1-6 (D/I variant),
- excessive leakage of exhaust gases into the oil sump of the lubrication system,
- increased noise level while the engine is running.

2.3.14 4C90 Repairs

Trouble	Reasons	Method of repair
1. the engine cannot be started	1.1. head gasket defective.	1.1 Replace the gasket, tighten the nuts with the required torque, adjust valve lashings
	1.2 Piston and ring worn out.	1.2 Replace the complete piston or piston rings.
	1.3 Leaking valves.	1.3 Reach or replace valves. Adjust the valve lashings.
	1.4 Lack of fuel or incorrect fuel grade.	1.4 Fill the container with the correct fuel grade.
	1.5. aerated fuel system.	1.5 Ventilate the oil fuel system.
	1.6. supply pump defective.	1.6 Replace defective parts or the entire pump.
	1.7 Contaminated fuel filter or fuel lines.	1.7 Replace the filter cartridge, blow out the hoses with compressed air.
	1.8 Injection pump switched off.	1.8 Switch on the pump (the control strip must not be in the "STOP" position).
	1.9. defective (worn) injection pump.	1.9 Repair or replace the pump.
	1.10. Incorrect injectors or nozzles.	1.10. Check, replace defective parts, complete injector or nozzle.
	1.11. Glow plugs or loose contacts of supply lines damaged.	1.11. Replace plugs, secure cables.
	1.12. Battery discharged.	1.12. Charge or replace the battery.
	1.13. Starting device damaged.	1.13. Repair or replace the starter unit.
	1.14. Damaged ignition (starter switch)	1.14. Replace the ignition.
2. The engine stops after starting.	2.1 Malfunctions as in points 1.4, 1.5 and 1.7.	2.1. method of repair according to 1.4, 1.5 or 1.7.
	2.2 Too low a temperature in the cooling system.	2.2 Restart, do not load the motor until the temperature has been reached min. 30°C.
	2.3. filler cap not fitted correctly.	2.3. introduce a fuel filler cap.
3. Engine running irregularly	3.1. Defects as in points 1.5, 1.6 and 1.10.	3.1. Method of repair according to points 1.5, 1.6 and 1.10.
	3.2 One of the pump delivery sections of the injection pump is missing	3.2 Return the injection pump for repair.
	3.3. Incorrect speed controller.	3.3 As in point 3.2.
	3.4 Too great a difference in injection pressures between injectors.	3.4 Adjust the injectors.
	3.5. one of the high-pressure lines is leaking.	3.5 Tighten the coupling nuts.
	3.6. leakage of one of the injectors in the head socket.	3.6 Tighten the clamping nuts.
	3.7. worn out timing belt drive Injection pump and camshaft fight.	3.7 Replace the timing belt
4. the engine does not run at rated power	4.1 Worn pistons and piston rings.	4.1 Return the engine for repair.
	4.2 Leaking valves.	4.2 Reach or replace leaking valves, adjust valve lashings.
	4.3 Defective (worn) delivery sections of the injection pump.	4.3, 4.4. Repair or replace the ejection pump
	4.4. faulty regulator.	

2.60 Table: 4C90 ENGINE TROUBLESHOOTING

4. the engine does not run at rated power	4.5 Incorrect angle of start of fuel delivery.	4.5 Adjust the angle at which pumping starts.
	4.6 Incorrect injection pressure.	4.6 Check and adjust injector pressure.
	4.7 Incorrect setting of the injection timing angle.	4.7 Set the injection timing.
	4.8. Injection advance angle adjuster defective.	4.8 Return the injection timing device for repair.
5. Motor stunts in operation	5.1 Loosening of the crankshaft screws.	5.1 Replace the screws of the main bearing retainers and the shaft of the crankhaft cover.
	5.2 Switched camshaft.	5.2 Set the timing.
	5.3 Fracture of the valve lever.	5.3 Fracture in the exchange valve lever
	5.4 Suspension of valves.	5.4 Eliminate the cause of valve suspension
	5.5 Incorrect setting of the angle at the start of injection.	5.5 Set the correct angle for the start of injection
	5.6 Used injectors.	5.6 Replace injectors.
6. Engine smoking	**Color of the exhaust gas is black**	
	6.1 Too low a compression pressure.	6.1 Return the engine for repair.
	6.2 Incorrect timing of the valve train.	6.2 Adjust the timing.
	6.3 Incorrect valve lashings or leaking valves.	6.3 Adjust relative valve lashings replace valves.
	6.4 Excessive fuel delivery.	6.4 Limit fuel delivery.
	6.5 Injection pressure too low.	6.5 Adjust the injectors.
	6.6 Too little injection timing.	6.6 Check and set the correct angle for injection prematurely.
	6.7. faulty nozzle.	6.7 Check the correctness of the spraying, replace if necessary.
	6.8. contaminated air filter.	6.8 Clean the filter cartridge with a new one, if necessary.
	6.9 Too great an external load on the engine.	6.9 Reduce the load, e.g. by shifting to a lower gear.
	Color of the exhaust gas is brown-blue	
	6.10. Worn or broken piston rings or broken piston grooves.	6.10. Replace complete rings or pistons.
	6.11. Stuck/baked piston rings.	6.11. Remove the carbon from the grooves of the piston rings.
	6.12. Excess oil in the engine.	6.12. Drain part of the oil from the oil sump.
	6.13. Engine idling too long.	6.13. Avoid long-term idling of the engine (load or switch off the engine)
	6.14. Engine operating temperature too low.	6.14. Cover the radiator.
7. Sudden stop of the engine	7.1 Piston seizure in the cylinder.	7.1 Replace the piston and cylinder liner.
	7.2 Suspension of valves.	7.2 Eliminate the cause of suspension behind the bags
	7.3 Lack of fuel.	7.3 Fill up with fuel.
	7.4 Dirty or clogged fuel filter.	7.4 Clean or replace the fuel filter insert
	7.5 Failure of the injection pump.	7.5 Replace the injection pump.
	7.6. contaminated air filter.	7.6 Replace the air filter cartridge
	7.7 Breaking or loosening of the timing	7.7 Have the engine repaired.

	belt of the drive of the injection pump and the timing belt drive.	
8. engine overheating	8.1 Excessive maximum fuel delivery.	8.1 Limit fuel delivery.
	8.2 Fuel injection too late.	8.2 Adjust injection timing.
	8.3 Too low an oil level in the oil sump.	8.3 Make up to the required level with oil in the bowl.
	8.4 Absence or insufficient level of coolant in the equalising tank and radiator	8.4 Stop the engine after it has cooled down and refill it to the required level.
	8.5 Dirty radiator core.	8.5 Clean the exterior surfaces of the radiator
	8.6 Slippage of the V-belt drive of the cooling system pump and alternator.	8.6 Increase the tension on the V-belt.
	8.7. fan solenoid clutch damaged or not adjusted; thermal breaker defective.	8.7 Replace damaged components, adjust solenoid coupling slots.
	8.8. Thermostat defective.	8.8 Replace the thermostat.
	8.9 Boiler scale in cooling system.	8.9 Remove the boiler stone.
9. Oil pressure too low	9.1 Oil level in the oil sump too low.	9.1 Fill up with oil to the required level.
	9.2 Used oil (low viscosity).	9.2 Change the oil.
	9.3. contaminated oil filter insert.	9.3 Replace the oil filter insert.
	9.4. oil pump suction hopper mesh dirty.	9.4. Remove the basket and clean the net.
	9.5. leakage in the lubrication system.	9.5 Find and remove leaks.
	9.6 Fuel or water in the lubrication system.	9.6 Find and correct the cause of fuel or water leaks into the lubrication system; replace oil.
	9.7. sensor or oil pressure gauge defective.	9.7 Replace the malfunctioning sensor or indicator.
	9.8. worn crankshaft bearings or camshaft bearings, lubricated under pressure.	9.8 Have the engine repaired.

Hull repair. Cylinder sleeves with deep cracks on the trackpad, broken or excessively worn (diameter at about 20 mm from the top surface of the sleeve is more than 90,08 mm) must be replaced. The new bushings are pressed onto the press with a minimum force of 6280 N. The inner diameter of the sleeve after pressing shall be 90,000...90,022 mm and its rim shall project 0,737...0,883 mm above the surface of the hull (Figure 2.99), provided that the axis of the sleeve is perpendicular to the axis of the crankshaft within 0,03/100 mm. The roughness of the cylinder smoothness shall be 0,8 μm.

Subsize of the pan	Shelf wall thickness, mm	Diameter of main pin, mm
0,25 0,50 0,75	2,095...2,105 2,220...2,230 2,345...2,355	69,731...69,750 69,481...69,500 69,231...69,250

Table 2.61: SELECTION OF BUSHINGS FOR REPAIR DIMENSIONS OF CRANKSHAFT MAIN PIVOTS

Repairing the main bearings of the crankshaft involves replacing the bushings, which are selected according to the repair dimensions of the main pivots with a clearance of 0.040...098 mm

(see Table 2-61). Hull with damaged upper plate surface, main bearing seat diameter greater than 74.019 mm and wall cracks passing through water or oil ducts are subject to replacement. The new hull or the repaired hull shall be leak tested. The test conditions are described in Section 2.3.1.

Repair of the head. The tilted lower surface of the head shall be repaired by grinding or lapping, provided that the maximum layer of material removed during these operations does not exceed 0,3 mm. A flatness tolerance of 0,1 mm in the direction of the longitudinal axis of the head, 0,05 mm in the direction of the transverse axis and 2,5 μm in the surface roughness is permissible.

The swirl chamber inserts are replaced when they are cracked or pitched in the channel connecting the cylinder. The collar of the insert is the headgear pavement with a pitch of 0.004..051 mm. When replacing the insert, special attention shall be paid to its correct position (the ball setting the axial position of the insert shall enter the groove made in the seat and the lower surface of its collar shall coincide with the lower surface of the head; the tolerance shall be ± 0,05 mm).

When verifying the combustion chamber inserts, check the thermal shields of the nozzles for damage and replace them with new ones.

Valve seats are repaired by regenerating them by grinding the joints or replacing them if they are excessively worn, cracked or crushed. The purpose of milling and grinding is to restore the surface to its original shape. The width of the flap after this operation should be 2...2,35 mm, the surface roughness should be 0,63 μm and the corners should be at their top:

- for an intake valve 120° ± 45',
- for an exhaust valve of 90° ± 15'.

The allowed deviation of the co-axiality of the flap with the guide is 0.05 mm and is achieved by using abrasive discs with the remote control in the valve guide (this condition forces the repair or replacement of the valve guides before the repair of the valve seats). In order to obtain the mentioned clearance width it is recommended to cut the sockets with front cutters of diameter:

- for an intake valve seat 43,9...44 mm,
- for an exhaust valve seat of 36,9...37 mm,

and then by means of the angle cutters with the above-mentioned apex angles.

If the grinder is missing, the seats can be reached with the cooperating valves (it is recommended to mark the valves with the cylinder number in which they were working, if this is the case).

The seats of the suction or exhaust valves to be replaced are cooled in liquid nitrogen to - 180°C and deposited in the press head:

- for intake valves 0,045...086 mm
- for exhaust valves 0,035...076 mm

The slides are replaced when the clearance between the valve stems and the inner holes increases by more than 0.090 mm. The new 59,5...60 mm long guides for suction valves and 63,5...64 mm long guides for exhaust valves shall be pressed into the head so as to project the upper flanges above the thrust surfaces of the valve springs at a height of 17,9...18,1 mm, ensuring a uniform

pressure for both guides of 0,010..0,046 mm. The internal diameters of the valve stem guideways should be 8,000...8.015 mm. If this dimension is not maintained, the guides must be replaced (if the dimension is larger) or drilled (if the dimension is smaller). The new or repaired head shall be leak tested. The test conditions are described in Section 2.3.2.

Repairing the head cap is limited to replacing the head cap if necessary:

- an increase of the camshaft bearing seat diameter by more than 50,025 mm,
- the lateral torsional buckling of the contact surface to the head of more than 0,05 mm (run-in is permitted), or
- cracks in the walls, which could cause oil leaks.

Repair of crankshaft piston engines

■ Worn or damaged pistons are replaced with new ones (no oversized pistons are produced for spare parts). A piston shall be eligible for replacement when available:

- bottom burnt, cracked or with deep pits,
- worn out surface (diameter measured in a plane perpendicular to the axis of the bolt hole at a distance of approximately 79,5 mm from the bottom should not be less than 89,840 mm),
- broken grooves into piston rings (clearances exceed 0.30 mm for: upper sealing ring (I), and 0.25 mm for: lower sealing ring (II) and scraper ring (III)),
- piston pin sockets increased by more than 30,008 mm (measured in a plane parallel to the piston rod axis).

■ Piston rings are replaced if they are damaged or if the outer diameter of the ring deteriorates, the gap in the lock is larger than 2,50 mm, and the degree of wear of the cylinder and piston calipers does not qualify them for repair yet. The spreading spring of the scraper ring is replaced when it is broken or weakened.

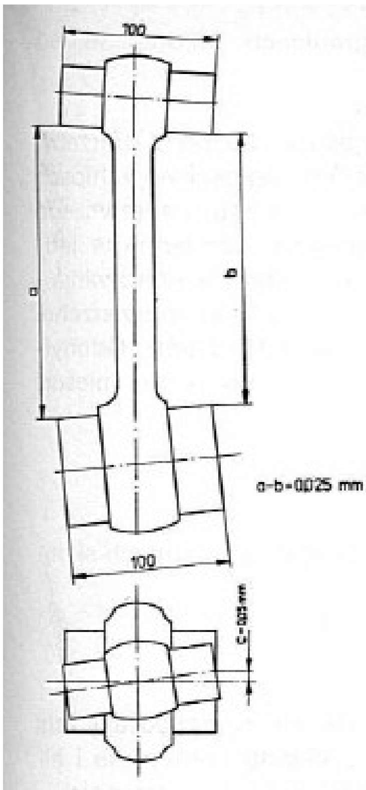
■ Piston bolts that are broken, cracked or worn (diameter less than 29,995 mm) must be replaced.

■ Cranks with distorted shafts or other visible surface defects shall be replaced.

The worn bushing in the crankshaft head is replaced by a new bushing, which, when replaced, protects the following: the position of the contact surface between the ends of the bushing (rolled up) on the side of the identification marks on the shaft and the head cover, as well as the overlapping of the oil hole with the hole in the crankshaft head. When pressed in, the inner hole of the sleeve is machined to 30,030...30,037 mm in accordance with the following conditions:

- the surface roughness shall be 0,63 µm,
- the axes of the holes in the sleeve of the head and the crankshaft seat in the shaft (checked with the test bolts) should not exceed the tolerances given in Figure 2.140.

■ Worn out crank shells are replaced by undersized shells used for repair dimensions of crankpins of crankshaft according to table 2-62.



2.140 Figure: PERMISSIBLE DEVIATIONS OF THE HEADSTOCK AND CRANKSHAFT AXES

Subsize of the pan	Shelf wall thickness, mm	Diameter of crankpin, mm
0,25 0,50 0,75	1,845...1,855 1,970...1,980 1,095...2,105	54,731...54,750 54,481...54,500 54,231...54,250

Table 2.62: SELECTION OF BUSHINGS FOR REPAIR DIMENSIONS OF CRANKPIN PINS OF CRANKSHAFT

■ Replace crankshaft screws with microcracks or extensions (overall length not within the limits shown in Figure 2.109). For subsequent identification, when installing bolts and nuts, the bolt and nut, which will be mounted on the opposite side of the retaining brackets of the half shells, must be marked with a point on the bolt head and the nut's side surface. Then measure and record the actual length of the two bolts to be mounted on the connecting rod. Tighten the nuts with a torque wrench (tightening torque 70...75 N·m) to an elongation of 0.110...0.140 mm and tighten before rotation.

■ The crankshaft shall be replaced in the event of bending, twisting, cracking or pits which cannot be removed during the repair process. Crack detection is recommended to be performed on a magnetic defectoscope, as visual inspection is in many cases not reliable. Shaft repair usually involves grinding worn pins and crankshafts for the next repair dimension and selecting repair panes (see Tables 2-61 and 2-62).

■ As a rule, the main and crankpin pivots are polished to the recommended identical repair dimensions. During this operation, special attention should be paid to the preservation of proper crankpin fillet radii ($3.5_{-0.5}$ mm for all main and crankpins) and proper roughness of these surfaces (up to 0.5 µm), in order not to cause undercuts (notches), which are places of stress concentration, causing fatigue shaft cracking. The length of the main pivots must be observed:

- the front, between 35,50 and 36,50 mm,
- the rear roller (which locates the axial shaft) within the range of 36,000 ... 36,050 mm,
- in the range of 36,000 ... 36,250 mm.

The stop faces of the retaining pivots may, if necessary, be ground to a mutual distance of 36 300 to 36 350 mm for the fitting of a repair set of retaining rings. They are manufactured for spare parts in one oversize with a thickness of 2.550...2.600 mm. During grinding and lapping of the pivots, the high quality of the surfaces cooperating with the bearing shells must be ensured (roughness 0.32 µm). Deviations in the shape of the service pins and crankshafts after repair shall be within the following limits:

- straightness 0,006 mm,
- wheelbase 0,012 mm,
- cylindrical gauge 0,006 mm

The position and runout of the pivots when supporting the shaft on the outer pivots (I and V) shall be reduced to a maximum:

- parallelism of the crankpin 0,03/100 mm,
- main pin II and IV 0,05 mm runout,
- runout of kingpin III (centre) 0,10 mm,
- breaking of the front journal to fit the drive pulleys: injection pump, camshaft, cooling pump and alternator 0,02 mm. The pivots should be nitrided cured.

The flywheel shall be repaired by grinding the surface in contact with the friction disc of the clutch when its flatness is greater than 0,07 mm, its surface roughness is 2,5 µm, and its runout is 0,1 mm (measured at 280 mm diameter) against the surface of the seat compatible with the rear face of the crankshaft flange. The toothed ring with worn or broken teeth is replaced by a new one.

Repair of a timing mechanism

■ The camshaft shall be replaced when the following defects are detected during the verification process:

- deep and uneven wear of the cams,
- deep cracks on the bearing pivots, cracks,
- defective keyway groove for the timing belt pulley of the camshaft drive,
- defective thread in the screw-in hole for the clutch fin of the vacuum pump drive,

- excessive wear of pivots (less than 49.91 mm),
- excessive wear of cams (the difference between the overall height of the cam and the diameter of its base is less: for a suction valve cam of 7,4 mm or for an exhaust valve cam of 7,3 mm).

■ The repair of valves consists in grinding their handles and mushroom sticks. Valve handles to maintain a play of 0.060...090 mm in guides should have a diameter of 7.925...7.940 mm. The valve bodies shall, after grinding, have a cylindrical lip thickness of at least 0,8 mm, a suction taper angle of 60 ± 5' and 45 ± 5' for the exhaust valve and a runout angle of up to 0,013 mm on the valve bodies. After grinding, it is recommended that the valve enters the seat and a leak test is carried out with compressed air at a pressure of 0.07 MPa. A pressure drop to zero in more than 15 seconds indicates that the repair has been carried out correctly.

■ Valve springs that are cracked, corroded, or weakened (use less than 670 N to compress from free to 35 mm control force) must be replaced with new springs.

Repair of the drive of the injection pump and the timing mechanism

The drive shaft bracket of the injection pump must be replaced with a new one if:

- the diameter of the front bearing seat is greater than 32,025 mm,
- the diameter of the rear bearing seat is greater than 38,025 mm,
- cracks in the housing that pass through ducts and oil spaces are detected.

The front bushing is replaced when the inner diameter of the bushing is greater than 22,021 mm. When reassembling, make sure that the lubrication holes in the sleeve and in the housing are aligned with each other. The gear wheel on the crankshaft can be replaced if the diameter of the hub bore is greater than 32,025 mm or if the groove width is greater than 8,00 mm.

The drive shaft of the injection pump shall be replaced if:

- the eccentric surface of the drive eccentric of the supply pump is worn out unevenly, - the toothed rim of the camshaft of the injection pump is worn out,
- the diameter of the front bearing journal is less than 23.959 mm,
- the diameter of the rear bearing journal is less than 43,950 mm,
- the journal diameter of the injection angle adjuster hub is less than 17,983 mm or when the groove width per key is greater than 5,00 mm.

Repair of the injection timing adjuster

The gear wheel (1, Fig. 2.125) is replaced when the diameter of the hole in the gear hub is greater than 28,021 mm or when the tines are excessively worn.

The adjuster hub (20, Fig. 2.125) is replaced with a new one if the diameter of the bearing journal is less than 27,927 mm and the diameter of the inner hole is greater than 17,027 mm, or if the width of the keyway groove is greater than 5,025 mm.

The weight bearing pins in the gear centre and hub (26, 30, Fig. 2.125) are replaced when the pivot diameters are smaller than 13,941 mm. The new pins are seated with a 0,010...0,046 mm press stud.

The spring seats (22, Fig. 2.125) are replaced when the diameter of the bearing holes is greater than 10,015 mm.

Complete weights (27, fig. 2. 125) are replaced when the diameter in the bearing sleeve is greater than 14,018 mm. When replacing the sleeve only, press the sleeve into the socket within 0,010...0,046 mm and drill the inside diameter into the sleeve to 14,000...14,018 mm. Replace the springs of the adjuster (24, Fig. 2.125) with new springs that are cracked, show signs of corrosion or do not meet the conditions specified in Table 2-57.

Repair of engine accessories

Repair of the fuel supply pump. If there is excessive clearance between the diaphragm drive lever and the axle on which the diaphragm is mounted, or if the surface at the end of the diaphragm drive lever that works with the eccentric on the injection pump drive shaft is excessively worn, both worn parts must be replaced at the same time. Other parts of the power supply pump that are worn or damaged are replaced with new parts.

Repair and adjustment of the PP4M7 injection pump should be carried out by a specialist workshop according to the manufacturer's repair documentation - MOTORPAL JIHLAVA (Czech-Slovak Republic).

Repair of injectors. Ad hoc repair of injectors is limited to replacement of worn or damaged parts. Full repair, as in the case of injection pumps, should be ordered to a specialist workshop and maintained in accordance with the repair documentation of the manufacturer, which are Warsaw Mechanical Plants.

Repair of the fuel tank shall be carried out according to the rules specified in Section 2.1.11.

Repair of oil pump. Worn or damaged oil pump elements are replaced with new ones, with the principle that rotors are replaced in pairs (internal and external rotors are manufactured for spare parts, selected in pairs with 0,02...0,06 mm interdental clearance, with their axis set at 3,5 mm eccentric displacement).

Replace worn or damaged cooling system pumps with new ones. The impeller with the worn surface for the sealant can be sanded and run in. The surface roughness shall not exceed 0,2 μm and the beating in relation to the rotor hub bore shall not exceed 0,05 mm. When in the free state, the sealant shall be 19 ± 0,3 mm long. Compressed to 15 ± 0,4 mm, an internal spring of 69...86 N must be overcome. Replace sealant that does not meet this requirement or that jams when the pressure is released. Replace the pump shaft as complete with the bearing when the axial clearance in the bearing is greater than 0,12 mm or when the bearing is noisy.

When assembling the pump after repair, the dimensions "a", "b" and "c" given in Figure 2.134 must be observed.

■ **Repairing the electromagnetic coupling** involves replacing worn or damaged parts.

When folding, please (fig. 2.134):

- Press the V-belt pulley hub onto the shaft, maintaining the position of the centre line of the wheel flange at a distance of d = 66,5 mm from the contact surface of the cover,
- Tighten the nut (1) to 58,8...68,6 Nm and secure with washer (2),
- Adjust the gap e = 0,25...0,35 mm with screws (27) and secure in this position using nuts (26).

■ Replace the damaged or deformed fan with a new one.

■ The thermostat that does not meet the conditions for the opening start temperature (82...85°C) and the full opening temperature (87°C) must be replaced.

■ The radiator is replaced by a new one if the core is damaged. Small damages to tanks or pipes are repaired by soldering.

Other engine and accessory parts that are worn or damaged are replaced with new ones as part of the repair process.

The engine shall be tested after the main engine repair. The sample shall consist of three steps:

- Stage I - checking the correctness of assembly and functioning of individual mechanisms and systems,
- Stage II - preliminary engine running-in,
- Stage III - measurement of parameters.

Working hours, min.	Speed, rpm	Combustion time, 200 cm^3, s	Engine power, kW
20	2100	131,4	13,7
30	2500	103,5	17,5
30	3000	85,0	22,5
30	3300	71,0	26,4
30	3800	53,7	32,3
30	4000	47,0	38,0
30	4100	40,1	42,0

2.63 Table: ENGINE RUNNING-IN PROGRAMME AFTER MAJOR REPAIR

Speed, rpm	Engine power, kW	Combustion time, 200 cm^3, s	Fuel consumption, kg/h
2500	38,5	59,7	10,0
4200	51,5	38,8	15,4
NB. Use a 0,83 kg/dm^3 specific mass fuel for the test, the engine power being that specified in BS.A4141:1971.			

2.64 Table: 4C90 ENGINE PERFORMANCE PARAMETERS AFTER MAJOR REPAIR

In stage I, after starting the engine, the tightness of the lubrication and cooling systems, the oil pressure and the correct functioning of the other mechanisms shall be checked when the engine is running at idling speed.

In the second stage, preliminary engine running-in is performed according to the program given in Table 2-63, however, the combustion time of the control fuel dose (200 cm) may be shorter than the one given in the Table by about 5%.

In stage III, after tightening the nuts fixing the head, checking the angle at which the fuel starts to be pumped, adjusting the oil pressure in the lubrication system (with the help of shims in the bypass valve), checking the valve play and the tightness of the fuel system, lubrication and cooling, the engine parameters are measured. The correct results are given in table 2-64, with the maximum speed not exceeding 4620 rpm. The engine shall continue to run in after it has been fitted to the vehicle (see section 8.2).

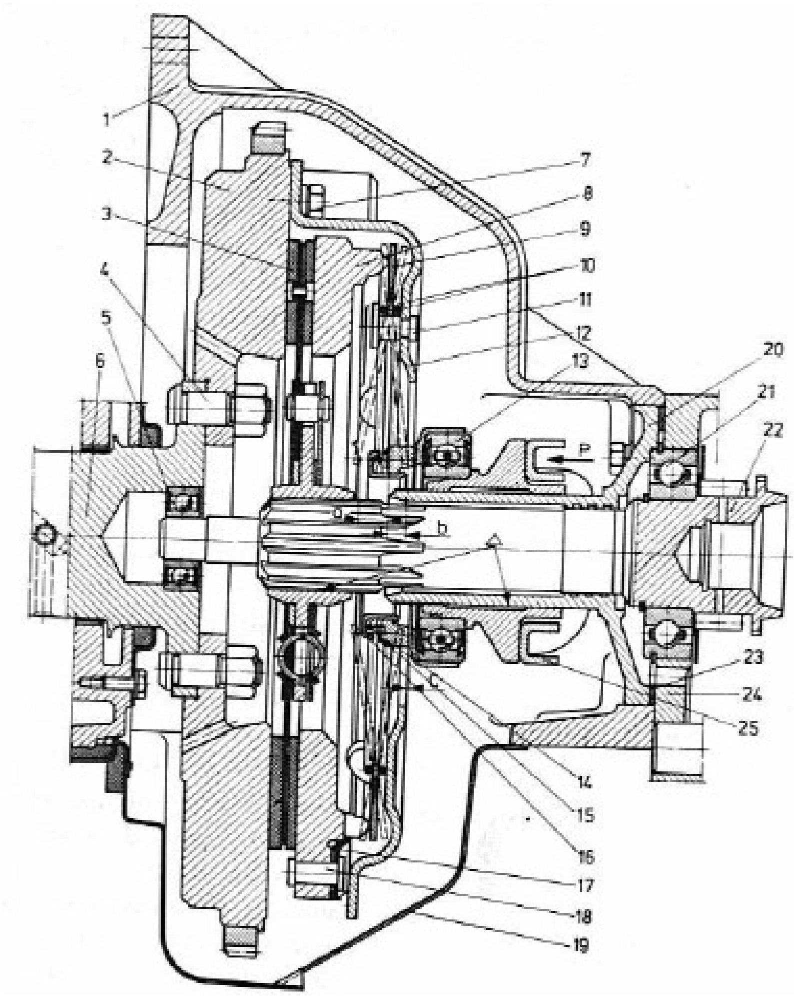
3 TRANSMISSION SYSTEMS

Żuk has a classic drivetrain. The front engine drives the rear wheels via transmission units such as clutch, gearbox, drive shaft and rear drive axle (with main transmission, differential and half drive axles).

3.1 CLUTCHES

Definition	Type of coupling	
	D02	200DBR
Type	dry, single disc with disc spring	
Friction lining: - outer diameter - inside diameter - thickness Torsional vibration damper friction torque Clutch torque Coupling flywheel torque Mass of the coupling	T 50S 225 mm 147 mm 3,5 mm 11...23 N·m 23 daN·m 0,06 kgm^2 5,7 kg	FT 201 200 mm 130 mm 3,4 11...18 N·m 16 daN·m 0,034 kgm^2 5,2 kg

3.1 Table: TECHNICAL CHARACTERISTICS OF THE CLUTCHES



1 - clutch housing, 2 - flywheel, 3 - clutch disc, 4 - clutch disc.7 - screws, 5 - coupling jib, 6 - crankshaft, 8 - compression ring, 9 - central disc spring, 10 - thrust ring, 11, 18 - rivets, 12 - coupling fitting, 13 - withdrawal sleeve, 14 - intermediate ring, 15 - spring ring, 16 - bushing, 17 - spring-loaded switch, 19 - lower clutch guard, 20 - front cover of gearbox housing, 21 - clutch roller bearing, 22 - coupling roller, 23 - bearing cover gasket clutch roller, 24 - gearbox housing, 25 - switch-off forks

1 - obudowa sprzęgła, 2 - koło zamachowe, 3 - tarcza sprzęgła, 4.7 - śruby, 5 - fożysko walka sprzęglowego, 6 - wał korbowy silnika, 8 - pierścień dociskowy, 9 - centralna sprężyna talerzowa, 10 - pierścień oporowy, 11, 18 - nity, 12 - oprawa sprzęgła, 13 - tuleja z łożyskiem wyciskowym, 14 - pierścień pośredni, 15 - pierścień sprężysty, 16 - tuleja, 17 - lacznik sprężysty, 19 - osłona dolna sprzęgła, 20 - pokrywa przednia obudowy skrzynki biegów, 21 - łożysko walka sprzęgłowego, 22 - walek sprzęgłowy, 23 - uszczelka pokrywy łożyska walka sprzęglowego, 24 - obudowa skrzynki biegów, 25 - widełki wylaczające

3.1 Figure: CLUTCH D02

3.1 CLUTCHES

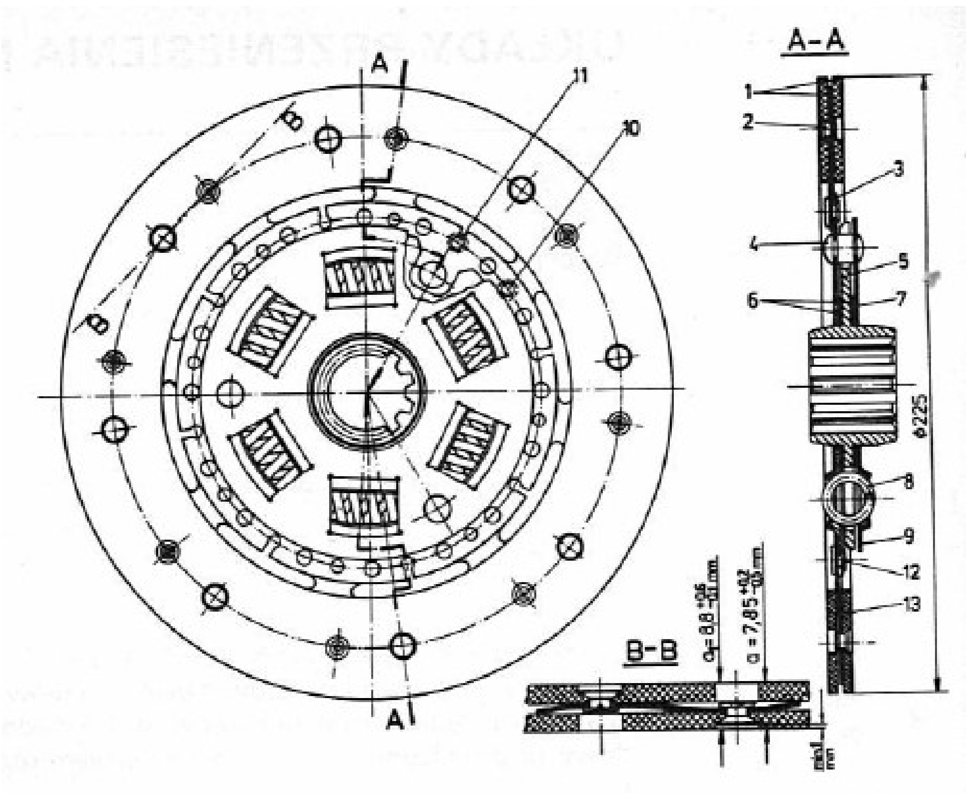
The clutch enables the engine to be disconnected or connected to the transmission during starting and stopping the vehicle and while driving, when shifting gears in the gearbox. The disc clutches used in the ŻUK car with the pressure disc spring type D02 and 200DBR are of similar construction and operate on the same principle. Their technical characteristics are compared in Table 3-1, where the DO2 coupling is used in conjunction with S-21 and 4C90 engines and the 200DBR coupling with CB engine.

3.1.1 DO2 Clutch

The clutch (Fig. 3.1) consists of the clutch disc (3), pressure ring (8), housing (12), central disc spring (9), thrust rings (10), bushing (16) with spring ring (15), bushing with pressing bearing (13) and an external cut-out. The whole is covered by the casing (1) and the bottom cover (19).

The function of the coupling is as follows.

- Drive switched on (clutch pedal released). The clutch disc (3), pressed against the central disc spring (9), rotates together with the flywheel (2) and the holder (12) to transfer the drive from the engine to the clutch shaft of the gearbox (22).
- Disconnect the drive (press on the clutch pedal). In the first phase of pedal movement, the pressing bush (13) is brought closer to the intermediate ring (14) and the play (C = 2 mm) between the two parts is eliminated (idle travel of the clutch pedal). In the second phase of movement (pedal travel), the central spring is gradually bent between the thrust rings (10), which reduces the clutch disc clamp until it is completely released (drive disconnected).



1 - friction lining, 2, 12 - rivets. 3 - disc, 4 - spacer rivet, 5 - hub, 6 - friction rings torsional vibration damper, 7 - adjusting ring, 8 - damping spring, 9 - rear hub disc, 10, 11 - balancing weights, 13 - elastic segment

1 - okladziny cierne, 2, 12- nity. 3 - tarcza, 4 - nit dystansowy, 5 - piasta, 6 - pierścienie cierne tlumika drgań skrętnych, 7 - pierścień regulacyjny, 8 - sprężyna amortyzująca, 9 - tylna tarcza piasty, 10, 11 - ciężarki wyważające, 13 - segment sprężysty

3.2 Figure: CLUTCH DISC (TARCZA SPRZĘGŁA) D02

- Switch on the drive (release the clutch pedal). When the clutch pedal is released, the pressing bearing is moved away from the flywheel and the central spring gradually returns

to its initial position, where it presses strongly on the clamping ring due to the elasticity of its external part, causing the clutch disc to be pressed between it and the flywheel (2). In order to improve the smooth running of the drive from the clutch disc to the hub and to protect the drive system against vibrations caused by engine operation (torque variability at each rotation), the clutch disc is equipped with a torsional vibration background consisting of six suspension springs (8 fig. 3.2) and two vibration dampening friction rings (6, fig. 3.2 placed between the hub flange (5, fig. 3.2), the disc (9, fig. 3.2) and the disc (3, fig. 3.2).

The complete clamping ring is dynamically balanced to an accuracy of 0.29 N·cm.

■ The clutch disc (Fig. 3.2) consists of a steel disc (3) with eight spring segments (each with two rivets) fitted with a rivet. Segment You (13) made of high manganese steel are corrugated ($1.8_{-0.2??}$ mm). In a new solution, the disc (3) was made as a single unit with the elastic segments (13), forming a monolithic elastic disc.

■ The cladding (1, Fig. 3.2), made of friction material T.50S, is riveted to the segments as shown in Figure 3.2 (Overhang B-B), which allows it to spring during the compression of the clutch disc. The outer friction surfaces of the cladding shall be $8{,}8^{+0{,}02}$ mm apart in non-released condition. Single cladding thicknesses shall be $3{,}5_{-0{,}2}$ mm, outer diameter 225_{-1} mm and inner diameter $147^{+0{,}8}$ mm. The rivet holes are $4{,}3^{+0.8}$ mm in diameter and $8{,}5^{+0.8}$ mm in diameter for head drillings.

■ The disc hub (5, Fig. 3.2) is a higher quality structural steel forging. It has a recessed spline with a bottom diameter of $35{,}128^{+0.152}$ mm and a rebate width of 5.397...5.435 mm for connecting the gearbox with the clutch shaft and six circumferential trapezoidal sockets (25.6x26.4x22 mm) for shock absorbers (8) and three peripheral (17x16 mm) for spacer rivets (4) for connecting the disc (3) to the hub disk (9). The retaining surfaces of the trapezoidal sockets are locally hardened.

■ The rear hub disc of the coupling (9, Figure 3.2) is made of 1,5 mm thick steel sheet. It has six rectangular-shaped holes, evenly spaced around its perimeter. The horizontal flanges of the holes are turned outwards at an angle of 38°. They prevent the suspension springs (8) from falling out.

■ The suspension springs for the clutch disc (8, Fig. 3.2) are made of spring wire with a diameter of 4,0 mm. Their outer diameter must be 18,9 ± 0,3 mm and their length in the free state must be 26,8 ± 0,3 mm. They are heat treated and shot peened and selected into two groups. For the first group, marked in blue, those springs are selected which require a force of 314...353 N to be compressed to a dimension of 25 mm, for the second group, marked in white, a force of 353...392 N. To one coupling disc springs from the same selection group (6 pcs.) or from two selection groups are mounted (pre-compressed), alternately with the second spring from the same group.

Before the hub clutch disc (9) is riveted, two torsional vibration dampers rings (6) made of asbestos rubber plate and a steel adjusting ring (7) are fitted between the hub disc and the hub flange. The rivet clamping force is selected so that the frictional moment of the torsional vibration damper is 10.8...22.6 N·m.

The complete clutch disc is statically balanced to an accuracy of 0.176 N·cm Larger unbalances are rectified by local grinding of the material on the outside diameter or by the attachment of balancing weights (10.11).

3.1.1 DO2 Clutch

■ A pressure ring (8, Figure 3.1) of grey cast iron, with an outside diameter of 228 mm, an inside diameter of 140 mm and a thickness of 28,35 ± 0,05 mm, shall have three equally spaced head restraints with holes of 7 ± 0,05 mm on the diameter of 247 ± 0,05 mm to be joined to the spring steel couplings. On the side opposite the working surface of the ring, on the diameter of 217 ± 0,3 mm, a tapered flange with an apex angle of 120° shall be formed, cooperating with the outer flange (on the diameter of 217 mm) of the centre spring disc.

■ The luminaire (12, Fig. 3.1) is an extrusion made of 3.5 mm thick steel sheet. The external diameter of the extrusion is 283 mm, internal diameter 128 mm, height 49,0 mm. The apertures with a diameter of $8^{+0,055}_{+0,015}$ mm and a diameter of 8,5 mm for the flywheel mountings of the luminaire shall be arranged circumferentially at the diameters of 263,5 ± 0,05 mm. Nine holes, $7,05^{+0,1}$ mm in diameter, evenly spaced over 162 ± 0,1 mm in diameter, serve to fix the centre disc spring to eight special rivets, 10,4 ± 0,1 mm in diameter.

■ The central disc spring (9, Figure 3.1) shall be made of a 2,62 ± 0,02 mm-thick ring-shaped wire-plate, truncated cone-shaped, with a base diameter of 223 + 0,5 mm, an apex diameter of 51 + 0,2 mm, and an angle between the forming and the base of 11° 23 ± 20'. There are 3.5+0.1 mm wide intersections on the side of the road with 11 +0.1 x 12.8 mm oval openings distributed over 162 mm diameter.

■ The stop ring (10, Fig. 3.1) is wound up of steel wire with a diameter of 3 mm. After welding, it is cyanated and hardened to 45...50 HRC. The inner diameter of the ring is $173^{+0,2}$ mm.

■ The resilient anchor (17, Figure 3.1) shall be made of 0,8 mm thick spring plate. The total length of the anchor shall be 76 mm, with fixing holes of $6,95^{+0,05}$ mm diameter spaced 59 ± 0,05 mm. The set consists of six pieces.

■ The intermediate ring (14, Fig. 3.1) is made of 2 mm thick steel sheet. It is cyanated and hardened to a hardness of 50 HRC. The inner diameter of the ring is $50^{+0.2}$ mm and the outer diameter is 78 mm.

■ The sleeve (16, fig. 3.1) is made of 1 mm thick steel sheet. Its inner diameter shall be $50^{-0,1}_{-0,2}$ mm and the diameter of the seat for fixing the spring ring shall be 57 ± 0,1 mm.

■ The spring ring (15, Fig. 3.1) is made of spring wire with a diameter of 2 mm and circumferentially wavy with an amplitude of $4_{-0.6}$ mm.

■ The switch sleeve (13, Fig. 3.1) is a grey iron casting. Its internal diameter, cooperating with the cover of the coupling shaft bearing (20, Fig. 3.1), is made to the size of $44^{+0.05}$ mm. The outer diameter of the withdrawal sleeve is $52,413^{+0.050}$ mm. The bushing has two protrusions for the shut-off forks (25, fig. 3.1) and a spring return catch (10, fig. 3.4), attached at the other end to the bracket, fastened to the screws of the gearbox cover.

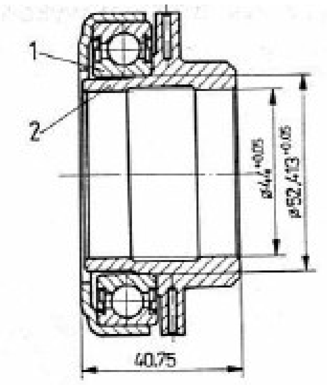
■ The thrust ball bearing (13, Fig. 3.1), marked CBK 197 (interchangeable with the previously used CBK 161 bearing), shall have an outside diameter of 85 ± 0,2 mm and a width of $19,25^{+0,1}_{-0,2}$ mm. Fourteen 8.731 mm (11/32 in) diameter balls in a riveted steel cage are shielded by plates. The free space between them is filled with grease ŁT-45. The clutch press bearing (Fig. 3.3) is suitable for linear control of the suspended pedal and consists of the replaced ball bearing CBK 197 (1) and cast

iron bushing (2) with inductively hardened (up to hardness 42 HRC) protrusions for use with switch-off forks. The basic dimensions of the sleeve are shown in Figure 3.3. In the sleeve projections, holes with a diameter of $2^{+0.2}$ mm are made for the graphical springs connecting the disconnecting forks to the sleeve.

■ The coupling housing (1, Fig. 3.1) for the S-21 is a grey cast iron motor with ribbed reinforced walls and flanges. The front flange is used to fix the housing directly to six screws and two centering pins on the engine hull wall, and the rear flange is used to fix the gearbox. The chassis base has four M8 threaded holes for attaching the lower clutch guard (an additional four screws are used to attach to the front flange) and two M12-hole inflators at the rear for attaching the chassis drive unit to the vehicle frame crossbar. A hole is provided in the rear face of the housing for fixing the flange of the gearbox clutch shaft bearing cover. This hole, $116^{+0,035}$ mm in diameter, and the front face of the rear flange are machined together with the engine hull (when the housing is screwed in). In the upper part of the front flange there shall be a sight glass (lockable by the cover) for checking the ignition angle. On the left side of the housing there is a cast-iron starter socket with two M12 threaded holes (for fastening screws).

The clutch housing for the 4C90 engine is a uniform cast iron screwed to the flywheel housing with eight M10 screws, the rear wall at the location and mounting point of the gearbox is identical to that of the clutch housing for the S-21 engine.

■ The bottom cover (19, Fig. 3.1) is an extrusion made of 0.9 mm thick sheet steel. It has the shape of a closed trough with two flanges, used to mount it to the coupling casing. A felt gasket is riveted to the vertical flange (for six 3x12 rivets) (23, fig. 3.1). In the bottom of the cover there is a drainage hole for the oil in the event of leaks in the rear crankshaft bearing or the clutch shaft bearing in the gearbox. The used cladding material of the clutch disc also falls out through this hole.



1 - bearing,
2 - bushing

1 - łożysko,
2 - tuleja

3.3 Figure: COUPLING OF CLUTCH SPRINGS

External clutch engagement mechanism : standing pedal version

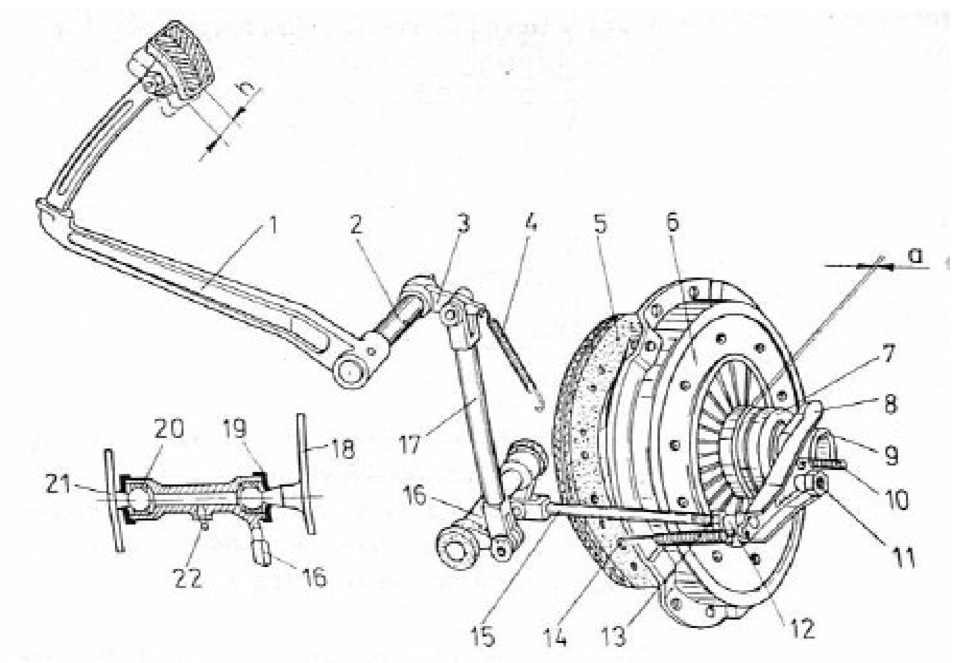
The external clutch cut-out (Fig. 3.4) consists of the clutch pedal (1) and the lever (3), which are mounted on the shaft (2), the tendon (17), the intermediate shaft (16), the tappet (15) and the switch-off forks (8) and the bearing (7). Two return springs (4 and 10) secure the return to the initial state. The overall gear ratio of the external mechanism shall be 10:1.

3.1.1 DO2 Clutch

■ The pedal (1), cast in malleable cast iron (I-section of arms), is ended on one side with a foot (with a plastic cap), fixed with M8x1, and on the other side with a hub with a hole of $22{,}17^{+0{,}05}$ mm for mounting on the shaft (2). The opening in the foot of the driver's cab (for the passage of the vertical arm of the clutch pedal) is sealed with a rubber groove on the shoulder, and the upward movement is limited by a rubber buffer screwed to the footrest from below.

■ The lever (3), forged from higher quality structural steel, has two hubs connected by an arm. One hub (with hole $22{,}17^{+0{,}05}$ mm) is used to attach the lever to the shaft (2), the other hub (with hole $10{,}2^{+0{,}105}_{-0{,}050}$ mm) is used to connect to the vertical string (17). The pedal and lever are fixed on the common shaft (2) by means of corrugated pins.

■ The $22{,}17_{-0.05}$ mm shaft (2) with an outside diameter of higher quality structural steel is supported by a bracket in the left-hand side of the frame; it is common to the clutch and brake pedals. The 15 mm diameter internal lubrication hole is ended with a grease nipple which is screwed in axially from the motor side. The grease outlet holes with a diameter of 6 mm are located under the brake pedal hub and under the bearing sleeves in the vehicle frame bracket.



3.4 Figure: CLUTCH PEDAL: STANDING VERSION

1 - clutch pedal, 2 - pedal shaft, 3 - lever, 4, 10, 14 - return and pulling springs, 5 - clutch disc, 6 - clutch pressure ring, 7 - compression bearing, 8 - shut-off forks, 9 - compression bearing sleeve, 11 - spherical pin for fork bearing,
12 - tappet adjustment rod, 13 - lock nut, 15 - tappet, 16 - intermediate shaft, 17 - drawbar, 18 - inner support for intermediate roller, 19 - protective ring, 20 - intermediate roller bearing, 21 - outer support for intermediate roller, 22 - grease nipple, h = 20...30 mm - barrel travel of the pedal

1 - pedał sprzęgła, 2 - wałek pedalu, 3 - dźwignia, 4, 10, 14 - sprężyny powrotne i odciągające, 5 - tarcza sprzęgła, 6 - pierścień dociskowy sprzęgła, 7 - łożysko wyciskowe, 8 - widelki wyłączające, 9 - tuleja łożyska wyciskowego, 11 - sworzeń kulisty łożyskowania widelek, 12 - końcówka regulacyjna popychacza, 13 - przeciwnakrętka, 15 - popychacz, 16 - wałek pośredni, 17 - cięgno, 18 - wspornik wewnętrzny walka pośredniego, 19 - pierścień zabezpieczający, 20 - tożysko walka pośredniego, 21 - wspornik zewnętrzny walka pośredniego, 22 - smarowniczka, h = 20...30 mm – skok jalowy pedału

■ The steel rod (17), ended on both sides with a fork, has holes in the arm hubs for fixing the pins 10 x 28, which connect the rod to the lever (3) and the intermediate shaft (16).

■ The intermediate shaft (16), cast in malleable cast iron, has two arms to connect to the string (17) and pusher (15). At both ends of the roller, seats with a diameter of $24^{+0.045}$ mm are recessed to secure the bearing (20) with an aluminium alloy and spherical pivots of the inner (18) and outer (21) supports. The intermediate shaft supports with pivots of $17^{-0.08}_{-0.18}$ mm diameter are attached internally to the motor housing and externally to the frame support.

The bearing on the side of the inner support is secured with an elastic circlip (19) to prevent it from slipping out. The bearing on the other side is slid-fitting, which allows for axial movement of the

roller (necessary for elastic hanging of the motor in the car frame). The bearings are sealed with rubber seals and lubricated with a common grease nipple (22).

■ The steel tappet (15) has a fork on one side to connect to the intermediate shaft for a 8x25 mm pin and an adjustable end (12) with a counter nut (13) on the other. The end (12) with M10x1 thread is ended with a ball $9{,}9_{-0.25}$ mm in diameter for use with the clutch shut-off fork (8).

■ Switch-off forks (8) made of 3 mm thick sheet steel are cyanated to a depth of 0.2 mm and hardened. The middle part is fixed in the coupling sleeve on the pin (with ball head) and secured with a spring-loaded handle. The forks work together with the pusher arms (15) and the pressing bearing sleeve (9). The arm ratio is 1,032:1. The opening in the clutch guard for the fork passage is sealed with a flexible artificial leather cover.

■ The pedal return springs (4) and the fork (14), made of 2,0 mm diameter spring wire, are attached to the brackets on the frame and on the coupling casing.

External clutch engagement mechanism : suspended pedal version

The clutch control mechanism in the version with the suspended pedal (Fig. 3.4a) consists of the pedal (10) connected by a cable (3) led in an armour (5) with the switching forks (17) supported by the ball pin (16) fixed in the clutch housing.

The introduction of the above change resulted in a reduction in the force required to switch off the clutch and simplified the mechanism and its adjustment. Two springs (9 and 20) provide the mechanism with a return to its initial state.

The total switch-off ratio is 16.7:1.

■ The pedal (10, Fig. 3.4a), which is essentially a double-acting lever, is a higher quality structural steel forging. One arm, 311 mm long, is fitted with a foot and the other with a 56 mm long hub with a pressed pin 8 mm in diameter to connect to the ring end of the elastic cable. The pedal is mounted on a common axle with the brake pedal, in a plastic sleeve with an inner hole of $18^{+0.260}_{+0.150}$ mm.

■ The elastic link (3.and 5, Fig. 3.4a) is a 1,095 mm long Bowden cable with an eyelet on one side and an M8x1.25 thread on the other.

■. The rod armour support for the 4C90 motor (13, Fig. 3.4a) is made of aluminium alloy and is attached to the coupling casing with two screws (14).

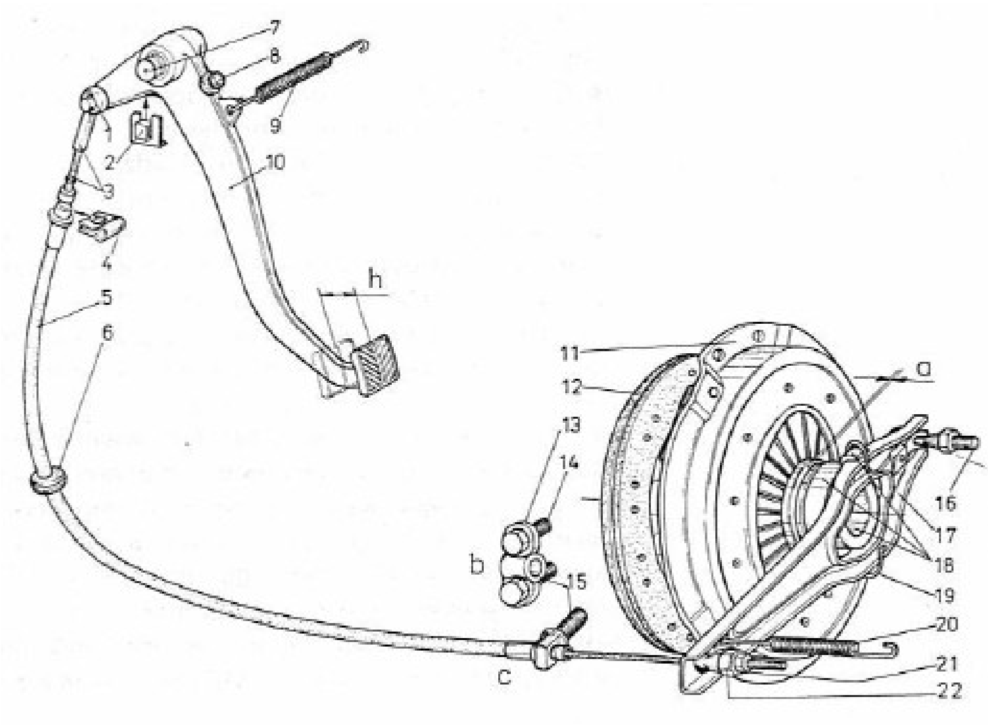
The bracket for the S-21 (15) motor is an eye-head screw that is screwed into the coupling casing.

■ The switch-off fork (17, Fig. 3.4a) is a one-sided lever made of 3 mm thick sheet steel, fixed on a 15 mm diameter Iba ball pin in the coupling sleeve. The cable entry hole has a diameter of $10{,}2^{+0.3}$ mm. The forks in their centre section work with the impression bearing flange.

The operation of the clutch includes the regulation of the idle stroke of the clutch pedal and the periodical lubrication of the external clutch shut-off mechanism. The idle travel of the pedal is adjusted by screwing in or removing the tip (12, Fig. 3.4) of the deactivation fork tappet (8, Fig. 3.4). After adjustment, secure the end of the tappet with a lock nut. Correctly adjusted idling stroke

of the pedal is 20 ... 30 mm. No-load travel adjustment with suspended pedal is carried out by means of a nut (22, Fig. 3.4a). Correctly adjusted pedal travel is 25...33 mm.

In the external clutch switching mechanism, the following are lubricated: the bearing sleeves of the clutch and brake pedal shaft (2, Fig. 3.4), the bearings of the intermediate shaft (20, Fig. 3.4) and the tendon pin (17, Fig. 3.4) and the pusher pin (15, Fig. 3.4). The bearings are lubricated with automotive chassis grease and the pins are lubricated with engine or transmission oil (a few drops).



1 - pin, 2, 4 - handles. 3- cable, 5 - cable armour, 6 - pass-through, 7 - axis of clutch and brake pedals, 8 - bumper. 9. 20 return springs, 10 pedals, 11 clutch fittings, 12 clutch discs, 13 cable armour supports for 4C90 engine, 14 screws. 15 - tendon armour support for motor S-21, 16 - ball pin. 17 - forks, 18 - forks, 19 - safety spring, 21 - lock nut, 22 - adjusting nut

1 - zawleczka, 2, 4 - uchwyty. 3- linka, 5 - pancerz cięgna, 6 - przelotka, 7 - oś pedałów sprzęgła i hamulca, 8 - zderzak. 9. 20 - sprężyny powrotne, 10 - pedal, 11 - oprawa sprzęgła, 12 - tarcza sprzęgła, 13 - wspornik pancerza cięgna dla silnika 4C90, 14 - śruby. 15 - wspornik pancerza cięgna dla silnika S-21, 16 - sworzeń kulowy. 17 - widelki wyłączające, 18 - tuleja łożyska wyłączającego, 19 - sprężyna zabezpieczająca, 21 - przeciwnakrętka, 22 - nakrętka regulacyjna

3.4a Figure: CLUTCH PEDAL: SUSPENDED VERSION

Periodic maintenance of the clutch also includes cleaning the ventilation openings in the clutch housing and the drain hole in the lower housing, as required.

The coupling is in good technical condition and can be adjusted correctly:

- full, periodic disconnection of the drive between the motor and the drive train,
- smooth connection of the motor to the drive train,
- transmission without slipping of the maximum motor torque,
- overload protection for the drive train in case of wheel drive (e.g. top travel with clutch engaged).

The technical performance of the coupling shall be assessed as follows when the vehicle is in service.

- full disconnection - when the clutch pedal is depressed and the engine is at idle, engaging or reversing in the gearbox shall not cause any clashes.
- smooth drive switching - when the clutch pedal is released smoothly, starting your car on a flat and level road should be smooth, without jerking, vibrations or noise.

- fully engaged drive (clutch operation without slipping) - when driving on 1st or 2nd gear, sudden pressing of the accelerator pedal must not increase the engine speed without a noticeable increase in the driving speed.
- noise - Variable speed driving (acceleration and deceleration) shall not cause excessive noise to the transmission system (caused by the clutch's operation).

The most common operating faults of the coupling, the reasons for them and information on how to fix them are presented in Table 3-2.

Repair of the coupling

During normal operation, the friction cladding of the clutch disc, the hub spline of the clutch disc, the working surfaces of the clamping ring, the shut-off sleeve, the compression bearing and the location of the external controls are subject to wear and tear. Damage is mainly caused to the clutch disc, the suspension and compression springs and the housing (cracks).

■ Friction linings that are burnt, cracked or excessively worn (rivet heads less than 0,25 mm from friction surfaces) shall be replaced. Riveting of new cladding is carried out in such a way that the rivets are at least 1 mm deep. The riveting procedure should ensure that the disc is laterally elastic (see section 3.1). The axial runout of the cladding, based on the hub thrust of the clutch disc, shall not exceed 0,8 mm over a radius of 100 mm and the tolerance for parallelism of the friction surfaces shall not exceed 0,4 mm. After the new cladding has been riveted, the complete disc is statically balanced according to section 3.1.1.

■ The clutch disc hub with worn spline, damaged rear hub disc, cracked spring segments, cracked or weakened suspension springs are replaced. Replacement of any of the above elements requires disassembling the complete disc and re-designing it. This repair, mainly to maintain the characteristics of the torsional vibration damper, must be carried out with special equipment. This is often the reason why, in case of emergency damage, the entire clutch disc is replaced with a new one.

■ The defective clamping ring is replaced by a new one.

■ Weakened or cracked springs are replaced by new springs from the same selection group as the other springs.

■ The broken coupling housing is replaced by a new one. Small cracks (except flanges) are repaired by hot welding with acetylene oxide or with bimetallic electrodes (copper-steel). The swivel contact surface of the housing flange is polished or streamed. After the repair, the housing is fixed to the engine hull and the alignment of the hole in the rear flange of the housing with the coupling shaft bearing seat in the flywheel and the perpendicularity of the flange surface to the crankshaft axis are checked. The positional deviations shall not exceed 0,08 mm.

■ The lower cover of the coupling, if indented or cracked, is welded and straightened.

■ Replace worn out outer clutch control pins with new ones. The use of oversize pins (1 mm larger than the nominal one) is permitted after reaming the holes in the forks of the tendon, tappet, lever and intermediate shaft.

■ The distorted switch-off forks are replaced with new ones. The surfaces cooperating with the tappet tip, the ball pin of the fork bearing and the pressing bearing sleeve are regenerated by welding and grinding to nominal dimensions.

Other components of the coupling and the external control mechanism are replaced with new ones if they are worn or damaged. After repair, the coupling shall be assembled and adjusted with a special device, paying particular attention to ensuring a full working stroke, which guarantees full disengagement of the coupling, taking into account the compensation resulting from wear of the friction linings during operation.

Trouble	Reasons	Method of repair
1. Incomplete disconnection of the clutch	1.1 Excessive idle travel of the clutch pedal.	1.1 Adjust the idling stroke of the clutch pedal (see Chap. 3.1.2).
	1.2. fractured, slackened or excessively worn clutch disc linings (friction surfaces less than 0,25 mm from the rivet head).	1.2 Replace damaged or defective riveted linings. Statically align the clutch disc.
	1.3. retracted clutch disc (lateral beating of the cladding more than 1 mm).	1.3 Replace the dislodged disc with a new one.
	1.4 Clogging or rubbing of the clutch disc on the clutch shaft spline	1.4 Replace the coupling disc or shaft with a damaged spline. Clean the clogging point and cover it with a thin layer of grease before installation.
	1.5 Fractured or weakened compression spring	1.5 Replace the clamping ring complete.
	1.6 Damaged, dislodged or showing signs of wear (cracks in the circumference) pressure ring.	1.6 Replace damaged clamping ring with new one.
	1.7 Loosening screws for the clutch housing.	1.7 Tighten the bolts to the required torque.
	1.8. the sliding sleeve of the impression bearing is seized	1.8 Start rubbing the area, lubricate the contact surfaces with grease.
	1.9. worn or damaged impression bearing.	1.9 Replace the bearing with a new one.
	1.10. Misalignment of the coupling shaft bearings.	1.10. Determine the cause, correct assembly or replace defective parts.
	1.11. Deformed tendons or switch-off forks.	1.11. Straighten or replace deformed parts.
2. Slippage of the coupling	2.1 Dirty, oily or excessively worn clutch disc linings.	2.1 Replace cladding with new one. Statically compensate the clutch disc.
	2.2 Continued or cracked clutch disc cladding	2.2. minor overburns, major overburns and cracked linings are eligible for replacement.
	2.3 Reason as in point 1.5.	2.3 Method of repair according to item 1.5.
	2.4. the clutch pedal travel is too low or not at all active.	2.4 Adjust the idle stroke of the clutch pedal (see Chap. 3.1.1).
	2.5. Sliding bearing sleeve seized or seized in the front position.	2.5 Method of repair according to point 1.8.
	2.6. weakened or cracked return spring of the clutch pedal.	2.6 Replace the defective spring.
	2.7 Hold the foot on the clutch pedal (while driving or stationary).	2.7 Not permissible; danger of burning the clutch disc cladding.

3.2 Table: CLUTCH TROUBLESHOOTING

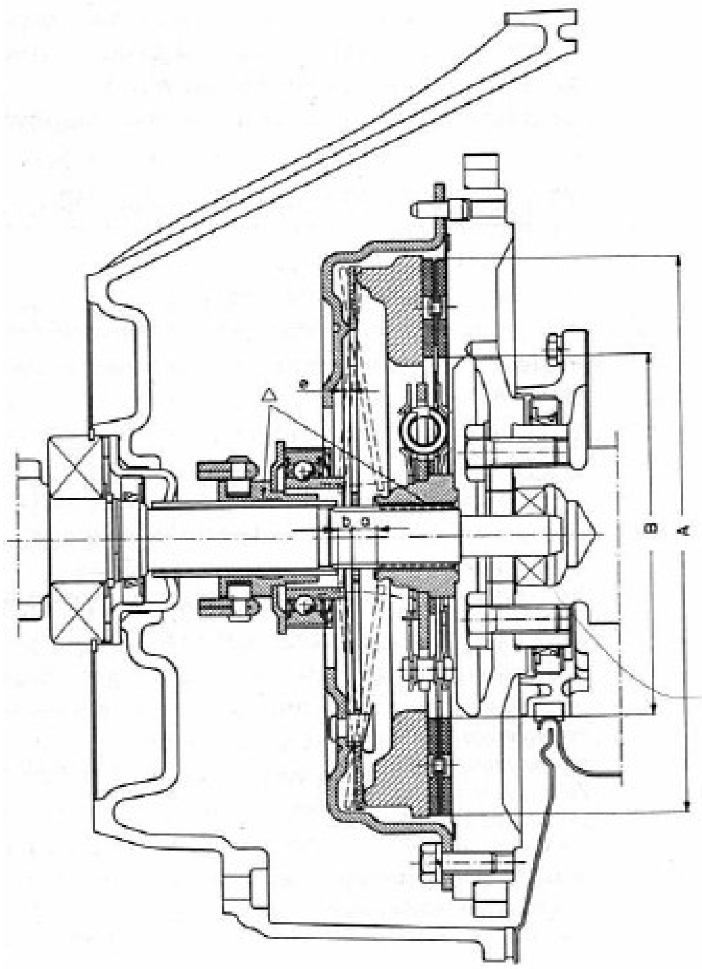
3. Jerking the clutch by engagement (starting the car) *Szarpanie sprzęgła przywłączaniu (ruszaniu samochodem)*	3.1 Fracture in the spring suspension of the clutch disc.	3.1 Replace the entire clutch disc. Have the individual springs replaced by an ASO or a repair company (adjustment of the torque of the torsional vibration damper).
	3.2 Unevenly worn or cracked clutch disc linings.	3.2 Method of repair according to point 2.1.
	3.3. spring breakage of the clutch disc.	3.3 Replace the entire disc with a new one. Have the individual segments replaced by an ASO or a repair company.
	3.4 Incorrect adjustment of the coupling.	3.4 Adjust the idle travel of the clutch pedal.
	3.5 Fixing screws loose or the coupling casing cracked.	3.5 Tighten the bolts to the required torque. Replace the broken housing at the ASO or repair shop.
	3.6 Reason as in points 1.3; 1.5; 1.6; or 2.1.	3.6. method of repair according to points 1.3, 1.5, 1.6 or 2.1.
	3.7 Damaged motor suspension in the frame.	3.7 Replace defective parts of the engine suspension system.
4. Premature wear of clutch linings	4.1 Reasons as in points 1.5; 2.4; 2.7; or 3.1.	4.1. method of repair according to points 1.5, 2.4, 2.7 or 3.1.
5. noisy operation when the clutch is switched off.	5.1. excessively worn multi-coupling hollow (radial clearance 0,5 mm, peripheral clearance 0,2 mm).	5.1 Replace the coupling shaft and, if necessary, the coupling disc.
	5.2 Defective or weakened return spring of the impression bearing sleeve.	5.2 Replace the return spring of the impression bearing sleeve.
	5.3. weakened or damaged return spring fork of the coupling cut-out.	5.3 Replace the return spring of the switch-off fork.
	5.4 Missed contact surfaces of the extruder bearing.	5.4 Replace the impression bearing. Adjust the clutch as described in point 2.4.
	5.5. worn coupling shaft bearings.	5.5 Replace worn bearings. Have the ASO or a repair shop carry out the repair.
	5.6 Reasons as in point 1.1 or 1.11.	5.6. Method of repair according to paragraph 1.1 or 1.11.
6. noisy operation when the clutch is switched on.	6.1. worn out front coupling shaft bearing (crankshaft).	6.1 Replace worn bearing. Have the ASO or a repair shop carry out the repair.
	6.2. misalignment of the installation of the engine with transmission.	6.2 Reassemble the unit.
	6.3 Misalignment of the coupling disc with the flywheel (tappets audible when the vehicle is idling).	6.3 Correct the setting if necessary by replacing the clutch disc (in case of radial run-out exceeding 1.0 mm).
	6.4. weakened, damaged or lost return springs of external clutch engagement.	6.4 Replace damaged springs, replace if necessary.
	6.5. bent clutch shaft.	6.5 Replace the damaged roller.
	6.6 Reasons as in point 2.4: 3.1, 3.9 or 5.1.	6.6 Method of repair according to points 2.4, 3.1, 3.9 or 5.1.

3.1.2 200DBR Clutch

The 200DBR coupling (Fig. 3.5) consists of the same components as the DO2 coupling, except that they are smaller (see Table 3-1), and in addition, the complete clamping ring (Fig. 3.6) has no intermediate ring (14, Fig. 3.1), spring ring (15) and bushing (16), as the impression bearing works directly with the central disc spring.

■ The 200DBR clutch housing is a component of the gearbox housing and not of the engine hull, as is the case with the DO2 clutch.

3.1.2 200DBR Clutch

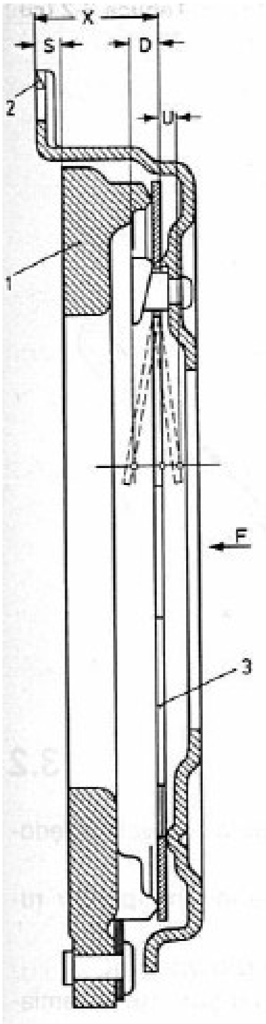


3.5 Figure: 200DBR CLUTCH

■ The external clutch cut-out (Fig. 3.7) consists of the clutch pedal (pos. 1...8) and the lever (15) mounted on a common shaft, a flexible tendon (11) and a return spring (17). The total gear ratio of the clutch engagement mechanism is 12.65:1.

■ A flexible pulley (11) with an overall length of 880 mm ends on one side with an 8 mm diameter ring end for connection to a lever on the common brake pedal shaft and the clutch pedal, and on the other side with an M8 threaded end for adjusting the idle travel of the clutch pedal.

3.1.2 200DBR Clutch



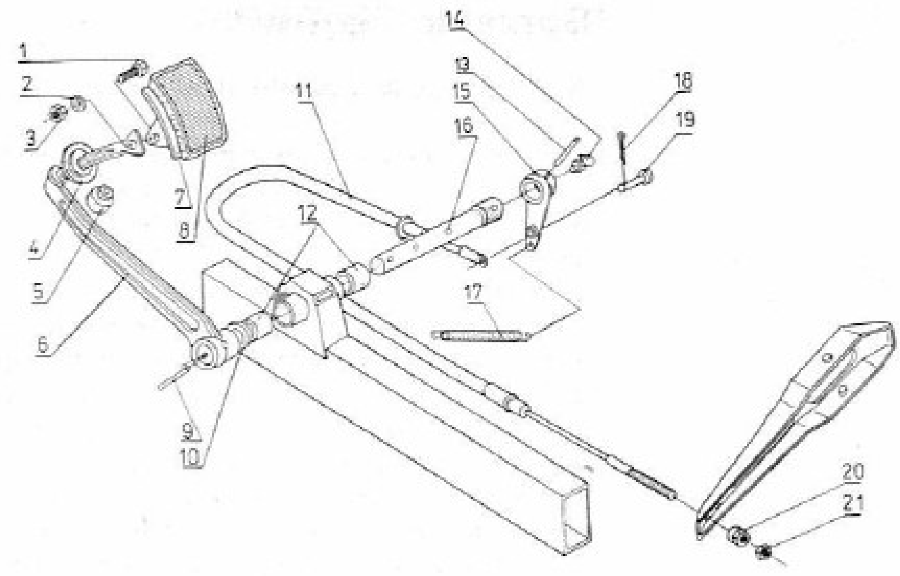
1 - compression ring,
2 - coupling fitting, 3 - central disc spring, D = 8.5...10 mm - cut-out travel, F = 1300 N - cut-out force, S = 8.2 mm - distance of pressure ring from flywheel, U = 4.7 mm - permissible increase in spring travel due to wear of friction cladding of coupling disc, X = 33.2...35.1 mm - control dimension in flat position of disc spring.

1 - pierścień dociskowy, 2 - oprawa sprzęgła, 3 - centralna sprężyna talerzowa, D = 8,5...10 mm - skok wylaczania, F=1300 N - siła wyłączania, S= 8,2 mm - odległość pierścienia dociskowego od kola zamachowego, U = 4,7 mm - dopuszczalne powiększenie skoku sprężyny w wyniku zużycia okladzin ciernych tarczy sprzęgła, X = 33,2...35,1 mm - wymiar kontrolny przy płaskim położeniu sprężyny talerzowej

3.6 Figure: CLUTCH CLAMPING RING 200DBR

1 - screw, 2 - 10 - pads, 3, 20, 21 - nuts, 4 - through-hole, 5 - bumper, 6 - pedal arm, 7 - foot, 8 - cap, 9, 13 - pegs, 11 - tendons, 12 - bearing sleeves. 14 - grease nipple, 15 - lever, 16 - pedal roller, 17 - return spring, 18 - pin, 19 - pin

1 - śruba, 2. 10 - podkladki, 3, 20, 21 - nakrętki, 4 - przelotka, 5 - zderzak, 6 - ramię pedału, 7 - stopka, 8 - nakladka, 9, 13 - kołki, 11 - cięgno, 12 - tulejki łożyskowe. 14 - smarowniczka, 15 - dźwignia, 16 - walek pedałów, 17 - sprężyna powrotna, 18 - zawleczka, 19 - sworzeń



3.7 Figure: 200DBR CLUTCH DISCONNECTION MECHANISM

3.1.2 200DBR Clutch

Correctly adjusted pedal travel is 25...30 mm. The coupling must be serviced and repaired as described in section 3.1.1.GEARBOXES

The gearbox transmits the torque from the clutch to the drive shaft, allowing it to be used in a wide variety of applications:

- driving at different speeds and overcoming variable movement resistances,
- reverse (reversing the direction of rotation of the main shaft),
- permanent disconnection of the engine from the transmission (engine start and idle).

The technical characteristics of the gearboxes are given in Table 3-3.

Definition	**Type of gearbox**			
	16	**A13.1**	**Polonez**	
Type of transmission:	mechanical with fixed-axis gearboxes			
I gear	3,115	3,753	3,778	3,778
II gear	1,772	2,372	1,944	1,944
III gear	1,000	1,482	1,307	1,307
IV gear	-	1,000	1,000	1,000
V gear	-	-	-	0,803
reverse gear	3,738	3,753	3,526	3,526
Synchronizers	inertia with ring blocking			
Synchronised gears	II, III	I-IV	I-IV	I-V
Speedometer gearbox ratio	3,4; 3,6; 4,1 (depending on the transmission ratio of the main drive bridge)			
Internal gearshifting mechanism	ball-snap-fastened hydrodisks			
External gearshifting mechanism	straightforward			
Lubrication	Olej Hipol 15		Olej Hipol 15F	
Mass (without external gear-shift mechanism)	21,8 kg	26,5 kg	-	

3.3 Table: TECHNICAL CHARACTERISTICS OF THE GEARBOXES

3.2 GEARBOXES

3.2.1 Type 16 Gearbox

Housing, shafts and gearboxes

In the cast iron housing of the box (20, Fig. 3.8) two shafts are installed: a clutch shaft (7) and a main shaft (9) and two axles: an intermediate wheel set (47) and a reverse gear intermediate wheel (51).

The coupling shaft (7, Fig. 3.8), connected via a coupling to the crankshaft of the engine, is mounted on the front in a ball bearing (6203 2RS) mounted in the crankshaft, on the rear in a ball bearing (6208 N) fixed in the gearbox housing by a ring (4). The shaft has two toothed rings: a fixed gearbox and a synchronizer. The main shaft (9, Fig. 3.8), connected to the drive shaft by a flange end (26), is mounted in a needle roller bearing (8), mounted in the coupling shaft and in a ball bearing (6306 N), fixed in the gearbox housing by a spring ring (23), and on the shaft by a crown nut (through the gear wheel of the speedometer drive and the flange end). The main shaft is fitted with a synchroniser hub, a 2nd gear gear wheel and a rear gear wheel.

The axle (47, fig. 3.8) is fixed in the housing walls and secured against sliding out and rotation by the plate (50). This axle is supported by bearings (on two roller bearings M-7118-1 and M-7121-1 separated by a spacer) of the intermediate gear units (44). The axial forces generated in the wheel assembly during torque transmission are absorbed by the gearbox housing by means of two $1{,}61_{-0{,}07}$ mm thick brown pads (41) and a 1,8 - 2,0 or 2,2 mm steel pad (42) with a deflection of 0,020 mm.

The axis of the reverse gear intermediate wheel (51, Figure 3.8) shall be determined in the headland and rear face of the gearbox and shall be prevented from sliding and rotating by the same plate (50) as the axle of the intermediate wheel assembly. The drive from the clutch shaft is transmitted via the gear set to the main shaft, with the exception of gear III, which is obtained by direct coupling of the clutch shaft to the main shaft by means of a synchroniser clutch (13). The l and reverse gears are obtained by connecting the sliding wheel (19) to the intermediate wheel assembly or to the reverse gear intermediate wheel (52). Gear II is obtained by connecting the synchroniser's toothed clutch (13) to the gear Number (16). The fixed gear wheels and the 2nd gear wheels remain in constant contact. These gearboxes have helical gearing wheels. The reverse gear intermediate wheel also remains in constant contact with the intermediate wheel assembly. The reverse gearboxes are fitted with straight gear wheels. Gearboxes and bearings are lubricated with gear oil in the gearbox housing.

Tightness of the box, apart from the cover gaskets, is ensured by: oil rejectors (6 and 21), rubber sealant (25) and labyrinth sealing made in the cover of the coupling shaft bearing. The overpressure in the gearbox is compensated for by an air vent with the atmospheric pressure.

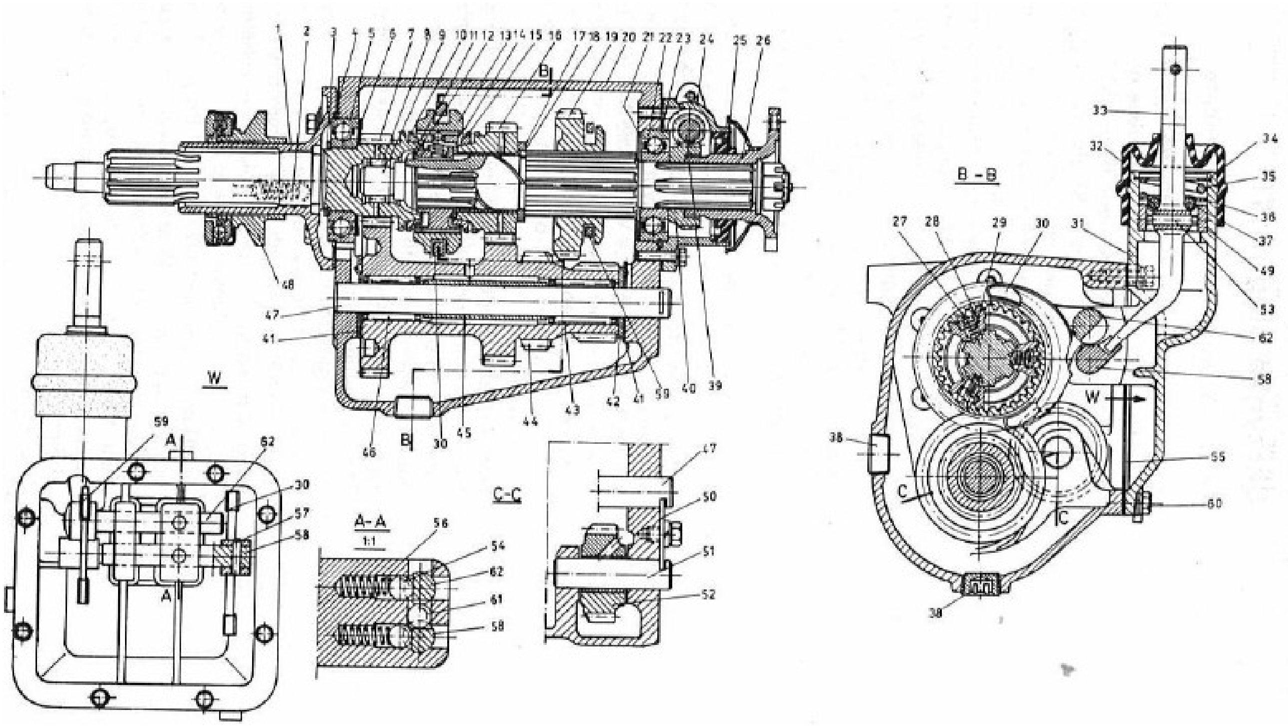
■ The gearbox housing (20, Fig. 3.8), cast in grey cast iron, has bearing seats and axle holes in the front and rear of it. The seat for the clutch shaft rear bearing is $80^{+0.018}$ mm in diameter, $72^{+0.018}$ mm for the main shaft rear bearing and $19{,}05^{+0.025}$ mm for the centre line of the intermediate wheel assembly and the reverse gear intermediate wheel. The distance between the axle of the clutch (main) shaft and that of the intermediate wheel assembly shall be $74{,}6^{+0{,}08}$ mm and between the axles of the reverse gear intermediate wheel and the intermediate wheel assembly shall be $52{,}375^{+0{,}08}$ mm.

3.2.1 Type 16 Gearbox

The gearbox housing is screwed on and sealed with cardboard or asbestos-end cap seals:

- cast iron coupling shaft bearing cover (1, Fig. 3.8),
- cast iron bearing cover for the main shaft (24, Fig. 3.8),
- aluminium alloy side cover (31, Fig. 3.8).

■ The coupling shaft bearing cover (1, Fig. 3.8) has a flange outer diameter (locating pin in the hole of the coupling housing) of $116^{-0.010}_{-0.050}$ mm. The diameter of the extended front cover is $44^{-0.075}_{-0.115}$ mm, which is the guide for the impression bearing sleeve, and the internal diameter, which is compatible with the journal of the clutch shaft, is $35{,}18^{+0.08}$ mm. A right-hand spiral anti-friction (labyrinth) channel with a 3 mm groove width and a depth of $0{,}5\ ^{+0{,}1}$ mm and a stroke of 6 mm is cut in this diameter.



3.8 Figure: GEARBOX TYPE 16

1 - front cover, 2 - return spring of coupling sleeve, 3 - bearing retainer rings on coupling shaft, 4 - bearing retainer ring on housing, 5 - ball bearing, 6 - oil jet, 7 - coupling sleeve, 8 - main roller needle roller, 9 - main roller, 10 - synchroniser ring, 11 - synchroniser hub settling ring, 12 - synchroniser hub settling ring. 15 - adjustment pads, 13 - sliding clutch of the synchronizer, 14 - synchronizer hub, 16 - gearwheel Gear quantity, 17 - stop ring, 18 - stop pin, 19 - sliding I and reverse gear, 20 - gearbox housing, 21 - oil ejector, 22 - ball bearing, 23 - bearing retainer ring, 24 - bearing retainer, 25 - sealant, 26 - main roller collar end, 27, 54 - balls, 28 - synchroniser stone, 29 - spring, 30 - fork 11 and gear Ill, 31 - side cover, 32 - guard, 33 - tap selector 34 - settling ring, 35'- compression spring, 36 - retaining pad, 37 - retaining ring, 38 - trigger and control plugs, 39 - speedometer transmission drive wheel, 40 - speedometer transmission drive wheel, 41 - gear set washer, 42 - gear set moveable pad, 43 - roller bearing, 44 - gear unit, 45 - distance sleeve, 46 - shaft bearing, 47 - intermediate gear unit axle, 48 - clutch compression sleeve, 49 - tap selector sleeve, 50 - retainer plate, 51 - wheel axle

1 - pokrywa przednia, 2 - sprężyna powrotna tulei lożyska wyciskowego sprzęgla, 3 - pierścieni osadczy łożyska na walku sprzęglowym, 4 - pierścień osadczy łożyska w obudowie, 5 - lożysko kulkowe, 6 - odrzutnik oleju, 7 - walek sprzeglowy, 8 - lożysko igielkowe walka głównego, 9 - walek glówny, 10 - pierścień synchronizatora, 11 - pierścień osadczy piasty synchronizatora, 12. 15 - podkladki regulacyjne, 13 - sprzęgło przesuwne synchronizatora, 14 - piasta synchronizatora, 16 - kolo zębate Il biegu, 17 - pierścień Oporowy, 18 - kolek zabezpieczający, 19 - kolo przesuwne I oraz wstecznego biegu, 20 - obudowa skrzynki biegów, 21 - odrzutnik oleju, 22 - lożysko kulkowe, 23 - pierścień osadczy łożyska, 24 - pokrywa tylna, 25 = uszczelniacz, 26 - końcówka kolnierzowa walka glównego, 27, 54 - kulki, 28 - kamien synchronizatora, 29 - sprężyna, 30 - widelki 11 oraz Ill biegu, 31 - pokrywa boczna, 32 - osłona, 33 - wybierak 34 - pierścien osadczy, 35'- sprężyna dociskowa, 36 - podkladka ustalająca, 37 - pierścien oporowy, 38 - korki spustowy i kontrolny, 39 - kolo napędzane przekładni prędkościomierza, 40 - kolo napędzające przekladni prędkościomierza, 41 - podkładka nieruchoma zespolu kół zębatych, 42 - podkladka ruchoma zespołu kół zębatych, 43 - lożysko wałeczkowe, 44 - zespól kół zębatych, 45 - tuleja odległościowa, 46 - łożysko waleczkowe, 47 - oś zespołu kół zębatych pośrednich, 48 - tuleja lożyska wyciskowego sprzęgła, 49 - tuleja lożyskowa wybieraka, 50 - płytka zabezpieczająca, 51 - oś koła

■ The cover of the main roller bearing (24, Fig. 3.8) made of grey cast iron has a hole with a diameter of $68^{-0.04}_{-010}$ mm for the seal and a socket with a diameter of $24^{+0.033}$ mm for the

speedometer drive shaft. The left-hand thread plate (0,5 ± 0,15 mm) is cut on the inside diameter of $42^{+0,034}_{-0,17}$ mm for the flange end as a sealing labyrinth.

■ The side cover (31, Figure 3.8) shall have a $40^{+0,05}$ mm diameter socket in the outer cylindrical overflow compartment for attaching the tap selector ball joint sleeve (49) and a $13^{+0,043}$ mm diameter hole in the inner rib-shaped projections with horizontal axes 20 ± 0,1 mm apart (for taper roller bearing). In the larger projection, perpendicular to the hole axis, two two two-stage holes with a diameter of $8^{+0.3}$ mm and $9.5^{+0.130}_{-0.040}$ mm are made for ball locks and one for ball locks with a diameter of $9.5^{+0.130}_{-0.040}$ mm for locking balls.

Definition	Dimensions, mm	
	16	**A13.1**
Front bearing journal diameter (crankshaft)	$17^{-0,012}_{-0,028}$	
Diameter of labyrinth seal journal	$35^{-0,075}_{-0,160}$	
Diameter of ring seal journal	-	
Diameter of the rear bearing journal (in the front wall of the coupling housing)	$40^{+0,015}_{-0,160}$	
Front bearing seat diameter of the main shaft	$26^{+0,020+0,007}$	
Multiplex		
- outer diameter	$35^{-0,075}_{-0,160}$	
- outlet thickness	5,335...5,385	

3.4 Table: PODSTAWOWE WYMIARY WAŁKÓW SPRZĘGŁOWYCH SKRZYNEK BIEGÓW 16 oraz A13.1

Definition	fixed gear wheel	near the synchroniser wreath
Number of teeth	15	30
Diameter of the indexing wheel	50,86 mm	62,301 mm
Angle of support	16°30’	30°
Angle of inclination of the tooth screw line	35°55’25’’	-
Direction of inclination of the tooth screw line	left	-

3.5 Table: GEAR CHARACTERISTICS OF THE CLUTCH SHAFT OF THE GEARBOX TYPE 16

Definition	Dimensions, mm
Front bearing journal diameter (in coupling shaft)	$20_{-0,009}$
Diameter of the pinion 2nd gear	$35^{-0,025}_{-0,038}$
Bear bearing journal diameter (in rear housing wall)	29,98...30,01
Synchroniser hub spline multidimensional	
- outer diameter	34,89...34,90
- thickness of projections	8,64...8,71
Multiple slide wheel and reverse gear splines	
- outer diameter	$42_{-0,07}$
- thickness of projections	5,95...5,99
Multi-wheel spline for speedometer transmission and flange end of drive shaft	
- outer diameter	29,98...30,01
- thickness of projections	7,82...7,87
Length of bout	278

3.6 Table: ESSENTIAL DIMENSIONS OF THE GEARBOX TYPE 16

■ The coupling shaft (7, Fig. 3.8), made of alloyed steel, is cyanated to a depth of 0,18 mm and hardened from the gear to the journal of the rear bearing. The basic dimensions of the clutch shaft are given in Table 3-4 and the characteristics of the gears are given in Table 3-5.

The friction cone, with an angle of inclination of 7°, shall be bedded in conjunction with the ring of the synchroniser so that the distance of the lateral planes is within 0,8...1,35 mm.

■ The main shaft (9, Fig. 3.8), made of alloy steel, is cyanated and hardened. Its main dimensions are given in Table 3-6.

■ The flange end of the main shaft (26, Fig. 3.8), forged from higher quality structural steel, is dimensioned:

- a pin cooperating with a sealant $42_{-0.10}$ mm,
- spline to be fixed on the main shaft: diameter of the bottom of the notches 30.026...30.077 mm; width of notches 7.899...7.950 mm.

■ The centre line of the intermediate wheel assembly (47, Figure 3.8) shall be of alloy steel. The diameter at the roller bearing seat is $19.05_{-0.012}$ mm. The axle is carburised to a depth of 0.9...1.2 mm and hardened.

■ The centre line of the reverse gear intermediate wheel (51, Fig. 3.8), made of higher quality structural steel, has an outside diameter of $19{,}05_{-0{,}012}$ mm. It is surface hardened to a depth of 1,5...2 mm.

■ The gear set of the intermediate shaft (44, Fig. 3.8), made of alloy steel, is cyanated to a depth of 0,18 mm and hardened. The diameter of the holes for roller bearings is $28{,}575^{+0.025}$ mm. The characteristics of the gear unit are given in Table 3-7.

■ The gear wheel in gear II (16, Fig. 3.8), mounted on the main shaft made of alloy steel, has 22 teeth with the screw line facing to the left. The diameter of the indexing wheel is 71,366 mm. The

angles of thrust and tilt of the screw line are the same as those of the 2nd gear in the gear set of the intermediate shaft. The synchronizer gear ring has the same dimensions as the clutch shaft ring. The inner diameter of the brown bushing in the wheel hub is $35,000^{+0.015}$ mm.

Definition	fixed gear wheel	gear II wheel	gear I wheel	reverse gear wheel
Number of teeth	29	24	18	15
Diameter of the indexing wheel	98,336 mm	77,856 mm	57,150 mm	47,625 mm
Angle of thrust (normal)	16°30’	16°30	20°	20°
Angle of inclination of the tooth screw line (on the indexing roller)	35°55’25’’	32°10’15’’	0°	0°
Direction of inclination of the tooth screw line	right	right	-	-
Tooth ring width	18,5 mm	20,5 mm	16,5 mm	24,5 mm
Interdental clearance in pairs of cooperating wheels	0,1...0,2 mm			

3.7 Table: CHARACTERISTICS OF THE ASSEMBLED GEARBOX TYPE 16

■ The gear wheel I and the reverse gear (19, Fig. 3.8), which are mounted on the main shaft, are made of alloy steel. The $19_{-0,5}$ mm wide rack has 29 straight tines. The diameter of the indexing wheel shall be 92,075 mm and the angle of thrust shall be 20°. The width of the rebates is $6^{+0.027}$ mm and the diameter of the bottom of the rebates is $42^{+0.037}$ mm. The width of the groove for the deactivation fork shall be 6,5 ± 0,1 mm.

■ The alloyed steel gear intermediate (52, Fig. 3.8) has the same gear characteristics as the gearbox first gear, except that the width of the rim is 21.5 mm. It reverses the direction of rotation of the main shaft and is mounted rotationally on a brown bushing with an inner diameter of $19,075^{+0.025}$ mm.

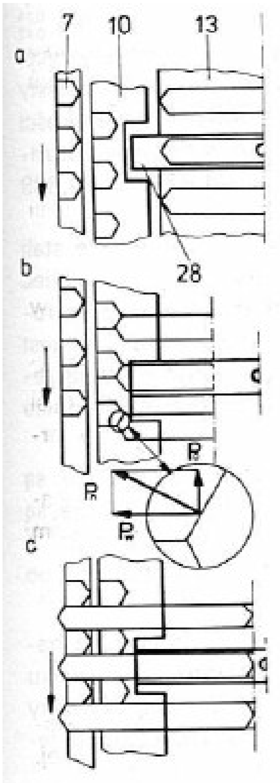
Synchronizers

Inertia bevel gearbox synchronisers with toothed ring locking (Fig. 3.8) allow the gearbox to be switched on only after the speed has been compensated for. The synchroniser is made up of a hub (14), fixed on a multi-outlet main roller by means of a set ring (11), stones (28) with claws and springs (29), two rings (10) and a toothed sliding clutch (13). The periphery of the hub is provided with an outer cut and three evenly distributed stone grooves (28). The sliding clutch is equipped with internal teeth and the same notches on stones as in the synchronizer hub. The synchroniser rings (10) have conical inner surfaces and outer toothed rings with the same tooth characteristics as the sliding clutch (13), clutch shaft (7) and 2nd gear gear (16).

The tapered surfaces of the rings are cut with threaded inserts (0.39 mm high) to extrude the oil between the faces to ensure direct contact. On the front surface of the rings (on the side of the synchronizer hub) three notches are made, the width of which is greater than the width of the stone (28) by about half of the pitch of the teeth cut on the rings. The faces of the tines of the sliding clutch and second-gear synchroniser rings are angled at an angle of 106°.

The movement of the sliding clutch (13, Fig. 3.8) towards the clutch shaft, induced by the forks (30, Fig. 3.8), causes the stones (28) to shift against the ends of the stones against the ring notches

(10) and the preload of the conical surfaces of the ring and the clutch shaft by means of a clip (27, Fig. 3.8). As a result of friction, the ring of the synchronizer is moved by the rotating clutch shaft to the point where the side surfaces of the notches are pressed against the stones. The tooth bevels of the sliding clutch (with a 106° apex angle) coincide at the same time with the tooth bevels of the track synchronization ring, preventing full wheel interlocking.



a, b, c.- successive switch-on phases (marked according to Figure 3.8)

a, b, c.- kolejne fazy włączania (oznaczenia wg rysunku 3.8)

3.9 Figure: OPERATING PRINCIPLE OF GEARBOX TYPE 16 SYNCHRONISER

In the places where the haunches are adjacent, a force perpendicular to their top (Pn) is generated; it can be treated as the sum of two forces: axial (Pw) and peripheral (Po). The axial force causes the ring to be additionally pressed against the conical surface of the clutch shaft by the synchroniser. As a result of increased friction between these surfaces, the rotational speed of the clutch and main shafts is evened out. At the same time, as a result of the circumferential force, the synchroniser ring starts to rotate in the opposite direction to the rotational speed of the clutch shaft until its teeth are aligned with the interlocking notches of the sprocket on the clutch shaft.

This creates the conditions for further shifting of the sliding gear clutch (13). Overcoming the resistance of the latch (ball 27, fig. 3.8), bending the spring (29, fig. 3.8), it hides in the stone and enters the full gearing, first with the toothed ring of the synchronizer ring and then with the ring of the clutch shaft synchronizer (7). Gear shifting II is the same as direct shifting, but the movement of the sliding clutch (13) is in the opposite direction.

■ The synchroniser hub (14, Fig. 3.8) is made of alloy steel. The hub is $23{,}5_{-0.084}$ mm wide and the pinion $29{,}5^{-0.14}_{-0.42}$ mm wide. The wreath has an external cut with characteristics such as a synchroniser wreath on the coupling shaft. Three $13^{+0.140}_{-0.050}$ mm wide, evenly spaced notches with

6.4-0.2 mm diameter spring sockets are provided on the periphery of the hub. The hub spline has a bottom diameter of 34,874...34,899 mm and rebate width 8,712...8,738 mm.

■ The synchroniser's sliding clutch (13, fig. 3.8), made of alloy steel, has internal gearing characteristics such as a synchroniser ring on the clutch shaft and an external $9{,}5^{+0.1}$ mm wide groove for the cut-off forks. The groove for the ball catch is made in the middle of the coupling width ($32_{-0.17}$ mm). The outer mean shall be 62,8 ± 0,07 mm and the width 6,4 ± 0,30 mm. The ball diameter of the latch is 6,35 mm.

■ The springs of the snap fasteners (29, Fig. 3.8), with a total number of coils of 7,5, are made of steel wire with a diameter of $1^{+0.03}_{-0.02}$ mm. The final coils are bent and ground. The outer diameter of the spring is $6{,}2^{+0.2}$ mm and its length in the free state is 12 mm, but when compressed to 22.54...27,44 N it shall be 9,5 mm.

■ The synchronizer rings (10, Fig. 3.8), made of bronze, have the same toothed rings as the synchronizer rings on the clutch shaft and the 2nd gear sprocket. Stone slots have dimensions (width x depth): $16^{+0.24}$ x $5^{+0.28}_{-0.32}$ mm. The cones with a 7° angle of inclination are lapped from the cone.

■ The synchroniser stones (28, Fig. 3.8), made of higher quality structural steel, measuring 24 x 13 x 5.5 mm (length x width x height), have a hole of $6{,}4^{+0.03}$ mm in mid-length for the balls of the snap-fasteners. They are cyanated and hardened.

The internal gearshifting mechanism (Fig. 3.8) consists of the tap selector (33), two tellers (58, 62) with forks (30, 59) and a locking and unlocking device, shown in section A-A. The selector is seated in a ball joint and secured with a pin (53) against rotation about the vertical axis. The longitudinal locking is secured by a spring (35) which presses the ball formed in the centre of the tap selector against the joint bushing seat (49) via a washer (36) and a ring (37). The upper end of the tap selector is used to attach the external gear lever, the lower end is used to move the shifting rods.

The waxes (58, 62) ended with forks are placed in the cover brackets. Forks I and 59 are welded to the fork (62) and forks II and III (30) are fixed on the fork (58) with a dowel (57). The position of the clamps (fork) in neutral or gear engaged is determined by the ball clamps (54 and 56). The locking ball (61) prevents the two guides from moving at the same time. The ball latches and the locking ball are located in the cover and work together with the V-shaped sockets on the outside of the hose. The selector is sealed in the cover with a rubber cover (32).

A diagram of the gear shifting is shown in Figure 3.10. In the neutral position of the gear shift lever, the selector at its lower end may move in a plane perpendicular to the longitudinal axis of the chiefs, and its stroke shall be limited by the resistance planes of the sockets at the ends of the chiefs.

To shift to gear I, move the outer gear lever in the direction of the driver's seat and backwards (opposite to the direction of travel). As the lever moves towards the driver's seat, the lower end of the tap selector enters the rectangular seat of the selector (62). During the rearward movement of the lever, the rod, fork (59) and wheel (19) move axially until they interlock with the first gear in

the intermediate gear set. The axial movement of the rod (62) causes the ball (61) of the rod (58) to lock and the upper ball catch to jump into the notch, which determines the position of the first gear.

The reverse gear shall be engaged in the same way, except that the external gear lever shall be moved from the forward neutral position.

When you return to neutral and move the outer gear lever to the maximum distance from the driver's seat and forward, you switch to 2nd gear and backwards to 3rd gear. In transmitting the motion to the sliding clutch of the synchronizer (13) the guide (58) and the forks (30) are intermediate. The ball (61) locks the cap (62), and the lower ball latch (as before, the upper ball latch) jumps into the notches that fix the position of the 2nd or 3rd gear.

■ The fork Top I and the reverse gear Top I (62, Fig. 3.8), made as a $13^{-0.016}_{-0.043}$ mm diameter alloyed steel thermal upgrading roller (cyanated), have three ball-slamming sockets cut at one end and one (in a plane perpendicular to the previous ones) for the locking ball and a 12,2 ± 0,05 mm wide rectangular outlet at the other for the lower end of the tap selector.

The sockets of the locking and unlocking device are V-shaped with a 100° double-walled angle and a $3^{+0.1}$ mm rebate bottom width. The plane of symmetry of the tap selector socket shall be 67,5 ± 0,1 mm from the plane of symmetry of the locking ball seat. The seat of the locking ball is located in the middle axis of the seat of the locking latch, but, as already noted, in a plane perpendicular to it. The front locating socket shall be 19 ± 0,1 mm from the centre (fork in reverse) and 20 ± 0,1 mm from the rear (fork in reverse). The depth of the seats (measured by the roller, shall be: front 10,5 ± 0,08 mm, rear and centre 8,5 ± 0,0 mm, and on a locking ball 10_{-013} mm.

■ The plug of the 2nd and 3rd gear forks (58, fig. 3.8) is made of the same type of material as the plug of the 1st gear and the reverse gear. The socket for the setting and unlocking device and for the lower room of the tap selector end are also of the same shape and dimensions. The difference consists in a different distance between the seat of the front (12 ± 0,1 mm) and rear (13 ± 0,1 mm) retaining devices and in the fact that the tap selector seat is not oversized by 12,2 ± 0,05 mm in width in a special husk cut at the rear end of the hose.

■ The forks / and reverse gears (59, fig. 3.8), forged from higher quality poisonous steel, are cyanated to a minimum depth of 0,??? mm, hardened and phosphated. Fork hub with inner hole 13+0.015-0.012 mm (to be fixed on the stem) has a tap selector seat of the same dimensions as the filler seat. The fork arms, 6 ± 0,2 mm thick, are machined on the inner side with a diameter of $50,4^{+0,2}$ mm, with the centre of the wheel $64^{+0,1}$ mm from the hub axis and a reduction of 20 mm from the hub axis.

■ The 2nd and 3rd gear forks (30, Fig. 3.8), made of the same grade of material as the 1st and 3rd gear forks, have an enlarged shoulder gland at the point where they work with the sliding clutch of the clutch to 8,9 ± 0,2 mm and an inside diameter of up to $73,4^{+0,2}$ mm.

■ The selector (33, fig. 3.8) of alloyed steel forged for heat treatment is cyanated to a depth of 0.1 mm and hardened. The tap selector bearing rod ball has a diameter of $25_{-0.1}$ mm, with a hole for a guide pin of $6^{+0.080}$ mm diameter. The upper end of the tap selector has a diameter of $14_{-0.027}$ mm and a hole for a setting pin with a diameter of $5^{+0.05}$ mm for the operation of the external gear-shift lever. The lower end, 39 mm apart from the longitudinal axis, is ended with a sphere $12_{-0,1}$ mm in

diameter, with local flattening to a thickness of $7_{-0,1}$ mm, in cooperation with the resistance planes of the seats in the guides.

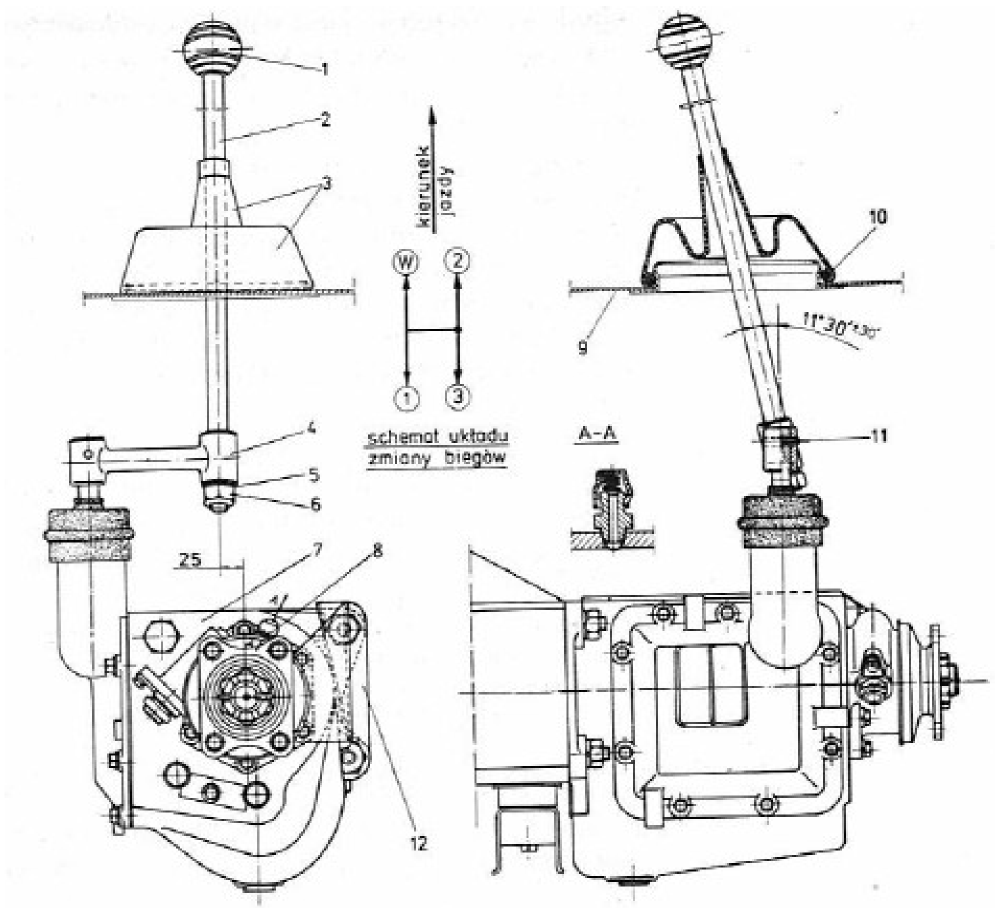
■ The tap selector bearing sleeve (49, Fig. 3.8), made of alloyed steel for thermal upgrading, is cyanated to a depth of 0,2 mm and hardened. The inner tap selector bearing seat is shaped like a ball with a diameter of $25^{+0.149}_{+0.065}$ mm. The tap selector pin guides are $5^{-0.04}$ mm wide. The height of the sleeve is $14_{-0.5}$ mm.

■ The tap selector pin (53, Fig. 3.8), diameter $6^{-0.010}_{-0.028}$ mm and length 31 ± 0.1 mm, made of alloyed steel for heat treatment shall be cyanated to a depth of 0.2 mm and quenched. The pins are milled to $5^{-0.060}_{-0.090}$ mm on both sides and are used in conjunction with the bearing sleeve guides.

■ The retaining washer (36, Fig. 3.8) with an outside diameter of 40,7 mm to 0,2 mm is made of 1,5 mm thick steel strip.

■ The compression spring (35, Fig. 3.8) is made of 5 mm diameter spring wire. The height of the spring in the free condition shall be 11 mm and 9 mm under a load of 559 ± 98 N.

■ The stop ring (37, Figure 3.8), made of 3 mm diameter spring wire, shall have an inner diameter of 21 ± 0,4 mm.



1 - handle, 2 - stick, 3 - cover. 4- gear lever arm, 5- spring pad, 6- nut, 7- gearbox, 8-ventilator, 9- cab floor. 10 - elastic ring, 11 - cat, 12 - safety device

1 - uchwyt, 2 - drążek, 3 - oslona. 4- ramię dźwigni przełączania biegów, 5 - podkladka sprężysta, 6 - nakrętka, 7- skrzynka biegów, 8 - odpowietrznik, 9 - podloga kabiny. 10 - pierścień sprężysty, 11 - kotek, 12 - zabezpieczenie

3.10 Figure: GEAR LEVER

■ The spring of the latch (56, Figure 3.8) with an outside diameter of 7,7 ± 0,08 mm shall be made of a spring wire with a diameter of 1,4 mm. Total number of coils - 10; final coils are bent and ground. The length of the spring in the free state shall be 23,6 mm and under a load of 92 N it shall be 19 mm.■ The external gear lever (Fig. 3.10) consists of a handle (1), a rod (2) and an arm (4).

The rod is connected to the arm by an M12 nut (6), secured with a spring washer (5). The lever is seated at the upper end of the tap selector and fixed with the pin (11). The hole in the cab floor (9) for the gear lever lever passage is sealed with a cover (3), fitted with an elastic ring (10).

The gear lever (2), ended on both sides with an M12 thread, is a steel rod with a diameter of 16 mm and a length of 537 mm. The diameter of the journal to be fixed in the hub of the lever arm is $12_{-0.1}$ mm. The gear lever arm (4), forged from higher quality structural steel, has two hubs with holes of $12{,}1^{+0{,}1}$ mm diameter (for seating the stick) and $14^{+0{,}043}$ mm (for fixing at the upper end of the tap selector). The distance between the holes is 105 mm.

The gear lever guard (3), made of Poroflex, has a spring ring (10) sewn into it, made of 3 mm diameter spring wire. The inner diameter of the ring shall be 118 ± 1,5 mm.

Gearbox operation

Gearbox operation includes:

- checking and, if necessary, repairing oil faults,
- to change oil,
- periodic checking of the attachment of the box to the clutch housing, the fixing of the covers (tightness) and the external gear-shifting mechanism.

The oil loss in the gearbox is checked and compensated for via the filling opening (control) on the side of the housing. The correct amount of oil in the housing is obtained by plunging: its level reaches the bottom edge of the filling opening.

Losses should be repaired with the same type of oil as the oil used in the box.

Replace worn out oil after the ride is complete (the minimum clearance must ensure that the mechanisms reach their normal operating temperature). Then turn off the drain, add 1,2 dm^3 of new gear oil and turn off the filler. When changing the oil, which is connected with a change of oil species, the gearbox is flushed with a new oil or oil. After 2...3 minutes, wash the engine, drain the oil and fill the casing with fresh oil.

The new or repaired gearbox shall be tested and meet the following technical conditions:

- the sum of the interdental clearances, when measured at the head shaft end (within a radius of 72 mm) and when the coupling shaft is stationary, shall exceed for:
    - gear I 0,8 mm,
    - gear II 1,75 mm,
    - gear III 0,9 mm,
    - reverse gear 1,2 mm,
- the rotation of the clutch and main shafts should be smooth (be: cut) when in neutral position or when gears are engaged;
- the shifting of individual gears must be carried out without jamming, the gearbox must not be switched off or two gears must not be switched on at the same time;

- quiet running should be characterised by uniform noise; knocks, knocks and knocking out noise of any gear - they are not acceptable
- the gearbox mechanisms should not be excessively hot during operation;
- the box should be tight; oil leaks through the sealants of the keys and the cover gaskets are not permitted.

If all the above conditions are met, the box must be approved for further use. The principles of correct operation of the box (sequence, recommended speeds of gear shifting for acceleration and deceleration, etc.) are discussed in detail in chapter 8, while typical weaknesses and information on how to remove faults are presented in table 3-8.

The casing is cracked or damaged with other mechanical damages and will be replaced by a new casing. Small cracks, outside the area of the shaft bearing seats, may be welded, if necessary, and the welding should be carried out intermittently to keep the housing temperature as low as possible, because the deformations caused by the stresses in the welding room may make it impossible for me to completely operate the gearboxes or steam them to wear out more quickly. After the repair, check that the following tolerances in shape and position of the housing surface are observed:

- concentricity of the coupling shaft and main shaft bearing seats 0,025 mm,
- parallelism of the axis of the holes fixing the axles of the intermediate gear unit and the reverse gear intermediate with the axis of the aforementioned jacking sockets up to 0,05 mm over a length of 210 mm,
- perpendicularity of housing front wall face to coupling shaft and main bearing seats - up to 0,04 mm at 65 mm pronunciation,
- the parallelism and perpendicularity of the inner faces of the front and back of the housing from the centreline of the holes with a diameter of $19{,}05^{+0{,}025}$ mm to 0 mm within a radius of 20 mm,
- parallelism of the mounting plane of the side cover to the axis of the seat of the bearings of the coupling shaft and the main shaft - up to 0,10 mm, length 1 mm, and flatness of this surface up to 0,1 mm.

If these conditions are not met, the housing must be replaced.

Covers damaged mechanically, with injured surface cooperating with gaskets, possibly worn surface of holes for shafts, leads, etc. are replaced with new ones, because of the inability to maintain required tightness and proper functioning of the internal gearshifting mechanism. It is only possible to grind the dislocated contact surfaces with a flat surface:

- 0,05 mm for the main shaft bearing cover,
- 0,15 mm for the side cover.

3.2.1 Type 16 Gearbox

Trouble	Reasons	Method of repair
1. difficult gear switching	1.1. incomplete disengagement of the coupling for the reasons given in Table 3-2 (see points 1.1 to 1.11).	1.1 Method of repair according to tables 1.1-1.13)
	1.2 Breaked or bent forks of the internal gear-shifting mechanism.	1.2 Replace damaged forks.
	1.3 Damaged or worn synchronisers.	1.3 Replace defective synchronizer parts.
	1.4 Excessive play in the movable connections of the external or internal gear-shifting mechanism.	1.4 Replace damaged parts.
2. noisy gearbox operation	2.1 Worn or damaged bearings.	2.1 Replace the bearings. Have the ASO or a repair shop carry out the repair.
	2.2 Too low an oil level in the housing.	2.2 Make up to the level of the filler cap.
	2.3. gear wheels damaged or worn (tooth play greater than 0,2 mm).	2.3 Replace worn out gears or shafts. Have the ASO or a repair shop carry out the repair.
	2.4. worn synchroniser rings (tooth clearance greater than 0,2 mm, worn surface of the friction cone).	2.4 Replace the rings. Have the ASO or a repair shop carry out the repair.
	2.5 Nuts for attaching the gearbox housing to the clutch housing too loose.	2.5 Tighten the nuts to the required torque.
3. automatic shift off of gears	3.1 Uneven wear of the gear teeth.	3.1 Replace the gear wheels. Have the ASO or a repair shop carry out the repair.
	3.2 Axial clearance of main shaft.	3.2 Tighten the clamping nut to the required torque.
	3.3. weakened or cracked spring of the internal gear-shifting mechanism catch.	3.3 Replace the spring of the latch.
	3.4 Defective spline on main shaft.	3.4 Replace the main shaft. Have the ASO or a repair shop carry out the repair.
	3.5 Reasons as in 1.2, 1.3 or 2.1	3.5. Method of repair according to paragraph. 1.2, 1.3 or 2.1.
4. gear shifting with grating *Przełączanie biegów ze zgrzytami*	4.1 Tooth chipping.	4.1 Replace damaged gears.
	4.2 Housing oil condensation.	4.2 Warm up while driving, without shifting.
	4.3 Reasons as in points 1.1, 1.2 or 2.4.	4.3 Method of repair according to 1.1, 1.2 or 2.4.
5. heating of the gearbox	5.1 Too little interdental clearance.	5.1 Replace or run in the gear wheels.
	5.2 Reasons as in points 2.1 to 2.3.	5.2 Method of repair according to items 2.1 - 2.3.
6. oil leaks	6.1 Too high an oil level in the housing.	6.1 Drain the excess with the filler cap (inspection plug).
	6.2 Damaged or worn cover gaskets and shaft seals.	6.2 Replace gaskets or seals.
	6.3 Loose cover screws.	6.3 Tighten the bolts to the required torque.
	6.4 Absence of breather blockage.	6.4 Clean or replace the vent.
	6.5 Casing or cover cracked.	6.5 Replace damaged parts. If the enclosure is replaced, have it repaired by an ASO or a repair company.
	6.6. oil drain plug not screwed on.	6.6 Tighten the drain plug to the required torque.
7. gearbox locked	7.1 Switching on two gears at the same time.	7.1 - 7.3 Have the ATS or a repair shop carry out the repair.
	7.2 Locking of the cooperating gear wheels by a foreign object.	
	7.3 Casing fractured.	

3.8 Table: GEARBOX TROUBLESHOOTING

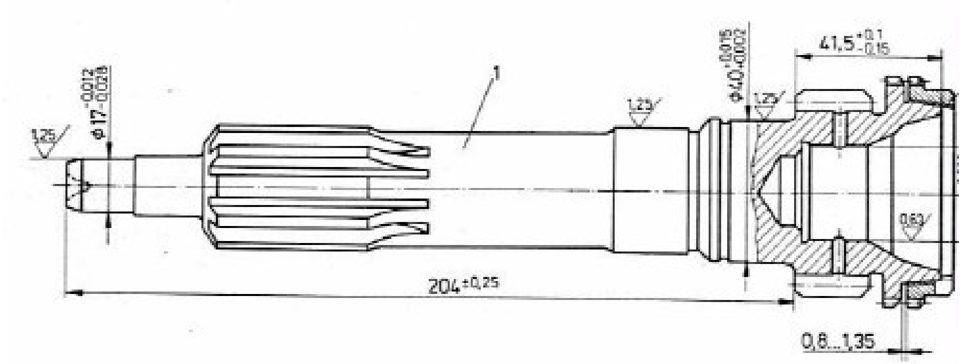
Repair of gearboxes

The coupling shaft is replaced by a new one if the gear wheel of the fixed gear unit is worn or damaged and the gear ring of the synchroniser is synchronised or if the shaft is flared up. It is permissible to chrome these pivots and the tapered surface cooperating with the synchronizer rings and to grind them to the nominal size while maintaining concentricity with the rear bearing journal up to 0,025 mm. The tapered surface must be reached with the ring working together to achieve a minimum of 75% adhesion and a lateral contact distance of 0,8...1,35 mm, as shown in Figure 3.11. The main shaft is replaced by a new one with worn or damaged splines. It is permissible to chrome

worn pins of the knuckle bearing and gear wheel in the 2nd gear and grind them to the dimensions of the nomine (tolerance of roundness and cylindricality of the pin of the needle bearing up to 0,008 mm) while maintaining concentricity in relation to the top of the external splines up to 0,025 mm. If the roller is not straight, its straightness must be kept within 0,12 mm (check on the grips).

Intermediate wheel-set axle with signs of wear on site bearings cooperating (diameter below 19.03 mm) and intermediate wheel-set axle in reverse gear with worn out surface cooperating with the toothed wheel-sleeve

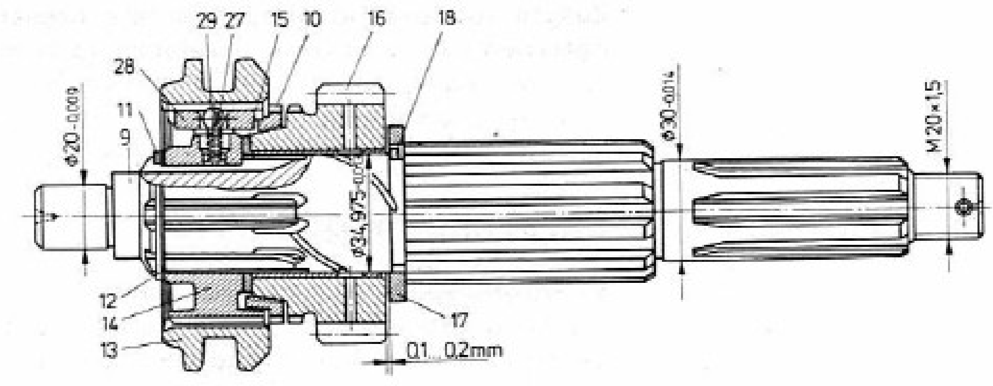
- shall be replaced or chrome-plated and ground to normal size.



1 - coupling shaft, 2 - synchronizer ring

1 - wałek sprzęgłowy, 2 - pierścień synchronizatora

3.11 Figure: COMPLETE CLUTCH SHAFT - MEASUREMENT OF THE FRONT DISTANCE OF TOOTHED CORDS AFTER THE TAPER SURFACES OF THE SYNCHRONIZER HAVE BEEN REACHED



9 - main roller, 10 - synchroniser ring, 11 - synchroniser hub settling ring, 12 - synchroniser hub settling ring. 15 - adjustment pads, 13 - sliding clutch of the synchronizer, 14 - synchronizer hub, 16 - gearwheel Gear quantity, 17 - stop ring, 18 - stop pin, 27 - balls, 28 - synchroniser stone, 29 - spring

9 - walek glówny, 10 - pierścień synchronizatora, 11 - pierścień osadczy piasty synchronizatora, 12. 15 - podkladki regulacyjne, 13 - sprzęgło przesuwne synchronizatora, 14 - piasta synchronizatora, 16 - kolo zębate II biegu, 17 - pierścień Oporowy, 18 - kolek zabezpieczający, 27 - kulki, 28 - kamien synchronizatora, 29 - sprężyna

3.12 Figure: WAŁEK GŁÓWNY KOMPLETNY - POMIAR LUZU OSIOWEGO KOŁA ZĘBATEGO BIEGU

Gear wheels with a clearance between the teeth exceeding 0,2 mm (check in pairs of co-operating wheels) and worn tooth surfaces (scratches, pitting, peeling) or broken teeth, as well as gear sets are subject to replacement in the event of wear of roller bearing raceways (diameter above 28.65 mm). Only wheels with slight damage (chipping) on the front surfaces of the teeth and traces of incomplete interlocking (thresholds) may be repaired by grinding for smoothing. The axial clearance of the gear 2nd gear mounted on the main shaft should not exceed 0,1...0,2 mm (Fig. 3.12) and that of the intermediate wheel assembly should not exceed 0,04...0,32 mm. In the case of larger clearances, they should be eliminated in the first case by means of adjusting washers (15, fig. 3.8) or by replacement of retaining washers (41, 42, fig. 3.8) in the second case. Worn brown

bushings of the 2nd gear gear bearing on the main shaft and of the reverse gear intermediate must be replaced and drilled to the nominal size, keeping the axis perpendicular to the face of the hubs with a deviation of up to 0,025 mm. The bushing bodies must be recessed at a distance of 1 mm from the hub faces for 2nd gear and 1,2 mm for 2nd gear intermediate, and the oil holes in the wheels and bushings must coincide.

Replace bearings that are corroded, damaged or worn. The degree of wear is determined by measuring the actual lateral clearance, which should not exceed 0,1 mm for the ball bearings of the coupling and main shaft and 0,07 mm for the needle roller bearing of the main rollers and the cylindrical assemblies of the intermediate gears (with a two-way load of 49...98 N).

Suitable synchronizer components are eligible for replacement if they have damaged toothed rings or if the interdental clearance in the cooperating pairs exceeds 0,2 mm. When replacing the hub and sliding clutch, a clearance of 0...0,010 mm between the co-operating gear rings must be maintained. The required clearance is achieved by run-in and individual selection of parts. The synchroniser rings (2nd and 3rd gear) with worn tapered surfaces (worn threads or the distance between the ring and pinion faces on the clutch shaft or gear wheel in 2nd gear less than 0,4 mm) must be replaced by new ones, reaching the cooperating parts so that the contact surface is not less than 75% and the distance between the faces is within 0,8...1,35 mm (see Fig. 3.11).

Among the parts of the gear shifting mechanisms, **the forks and guides on the contact surfaces** with the cooperating components wear out the most quickly. Worn out forks surfaces are repaired by hard electrode welding, and the leads are electrolytically chromium plated and polished to nominal dimensions.

Wear and tear on other external parts and in the clawshift gearshifting mechanism are usually replaced by new ones, if necessary, by repairs with well-known locksmith methods (straightening, reaming of holes, use of measuring pins, etc.).

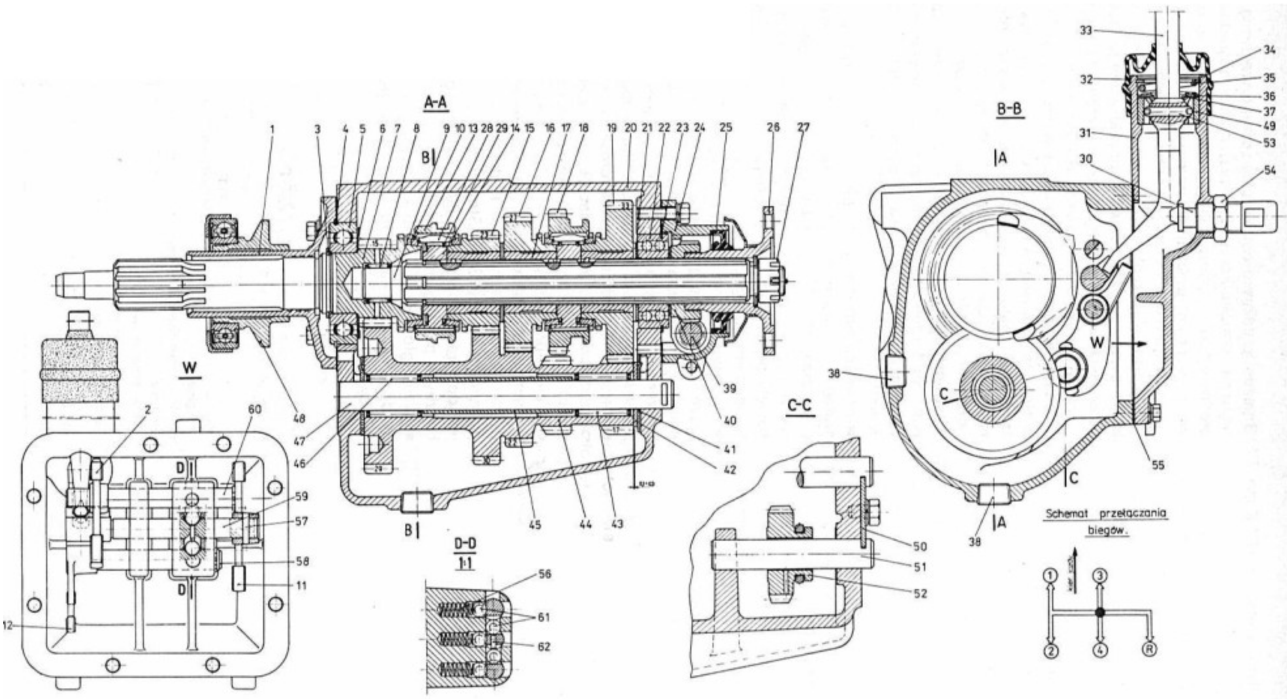
3.2.2 Type A13.1 Gearbox

The gearbox type A13.1 is unified in construction from the gearbox type 16 (differences and similarities in the design and operation described in this chapter). The construction of the gearbox is shown in Figure 3.13 and its technical characteristics in Table 3.3.

Housing, shafts and gearboxes

In the cast iron housing of the box (20, Fig. 3.13) two axles in the coupling (7) and in the main (9) are installed: the intermediate wheel set and the reverse gear intermediate wheel (51). The coupling shaft (7), connected via a coupling to the engine crankshaft, is mounted in front on a ball bearing (6203 2) mounted in the crankshaft, in rear on a ball bearing (6208 fixed in the gearbox housing by a ring (4). The shaft has two toothed rings cut: a fixed gearbox and a synchronizer.

The main shaft (9), connected to the drive shaft by a narrow-end flange (26), is mounted in a needle roller bearing (8), the coupling shaft seating and fixed in the ball bearing (3206 N), (in the gearbox housing by an elastic ring (23) of the shaft by a crown nut (via the speedometer drive gear and



3.13. Figure: TYPE 13.1 GEARBOX

1 - front cover, 2 - forks I and I, Shifting number, 3 - bed lock ring on spherical roller, 4 - bed lock ring on housing, 5 - ball bearing, 6 - oil jet, 7 - spherical roller, 8 - needle lock on main roller, 9 - main roller, 10 - synchronizer ring, 11 - forks III and IV gear, 12 - reverse gear forks. 13 - Synchronizer sliding clutch, 14 - Synchronizer hub, 15 - 3rd gear gear gear gearbox, circle see Gear quantity, + bearings sleeve, 18 reverse gearboxes, 19 - 1st gear gauge gauge wheel, 20 - gearbox housing, 21 - spacer washer, 22 - double row angular contact ball bearings, 23 - Tool settling ring, 24 - rear cover, 25 - sealant, 26 - Olnierz end of main shaft, 27 - crown nut, 28 - synchronizer stone, 29 - synchronizer elastic ring, 30 - tap selector bumper, 31 - side cover, 32 - cover, 33 - tap selector, 34 - settling ring. 35 - Pressure sleeve. 36 - locating washer, 37 - stop ring. 38 - oil drain plugs and check plugs, 39 - speedometer gearbox drive wheel, 40 - speedometer gearbox drive wheel, 41 - gearbox base, 42 - gearbox washer, 43 - shaft seal, 44 - gearbox unit, 45 - spacer sleeve, 46 - shaft bearing, 47 - axis of intermediate gear unit, 48 - clutch compression sleeve, 49 - tap selector ball sleeve, 50 - retainer plate, 51 - from reverse gear intermediate wheel, 52 - reverse gear intermediate wheel, 53 - tap selector pin, 54 - tap selector stroke limiter, 55 - side cover gasket. 56 click spring, 57 click stud. 58 Rear-running forklift, 59 Rear-running forklift, III-running forklift, 60 Running forklift, 61 Locking balls, 62 Locking pin

1 - pokrywa przednia, 2 - widelki I oraz Il biegu, 3 - pierścien osadczy lożyska na walku sprzeglowym, 4 - pierścien osadczy lożyska w obudowie, 5 - lożysko kulkowe, 6 - odrzutnik oleju, 7 - walek sprzeglowy, 8 - lożysko igiełkowe walka głównego, 9 - walek główny, 10 - pierścień synchronizatora, 11 - widelki III oraz IV biegu, 12 - widelki wstecznego biegu. 13 - sprzęgło przesuwne synchronizatora, 14 - piasta synchronizatora, 15 - kolo zebate III biegu, kolo zobate Il biegu, + tulejka lożyskowa, 18 kolo zebate wstecznego biegu, 19 - kolo zobate I biegu, 20 - obudowa skrzynki biegów, 21 - podkładka odległościowa, 22 - lożysko kulkowe skośne dwurzędowe, 23 - pierścien osadczy tożyska, 24 - pokrywa tylna, 25 - uszczelniacz, 26 - końcówka olnierzowa wałka glównego, 27 - nakrętka koronowa, 28 - kamien synchronizatora, 29 - pierścień sprężysty synchronizatora, 30 - zderzak wybieraka, 31 - pokrywa boczna, 32 - oslona, 33 - wybierak, 34 - pierścień Osadczy. 35 - sprotyna dociskowa. 36 - podkładka ustalająca, 37 - pierścień oporowy. 38 - korki spustowy i kontrolny oleju, 39 - kolo napedzane przekładni prędkościomierza, 40 - kolo napędzające przekladni predkościomierza, 41 - podkladka nieruchoma zespołu kół zębatych, 42 - podkładka ruchoma zespołu kół zębatych, 43 - fożysko waleczkowe, 44 - zespół kół zębatych, 45 - tuleja odleglościowa, 46 - łożysko waleczkowe, 47 - oś zespołu kol zębatych pośrednich, 48 - tuleja lożyska wyciskowego sprzęgla, 49 - tuleja tożyskowa wybieraka, 50 - plytka zabezpieczająco, 51 - od kola pośredniego wstecznogo biegu, 52 - kolo pośrednie wstecznego biegu, 53 - sworzeń wybieraka, 54 - ogranicznik skoku wybieraka, 55 - uszczelka pokrywy bocznej. 56 - sprężyna zatrzasku, 57 - kolek. 58 - wodzik widelek wstecznego biegu, 59 - wodzik widelek III IV biegu, 60 - wodzik widelek Lill biegu, 61 - kulki ryglujące, 62 - kolek ryglujący

flange end). The main shaft is fitted with: a synchroniser pint, a III gear wheel, a bi-back gear wheel and a III gear wheel.

The axle (47) is fixed in the housing walls and secured against loosening and rotation by a plate (50). Two roller bearings M-7118-1 and M-7121-1 (spacer spacer spacer spacer spacer spacer spacer spacer spacer spacer spacer) are mounted on this axle (44). The ec forces, which arise in the wheel assembly when torque is transmitted, are absorbed by the gearbox housing via two 1.61-0.07 mm thick bronze pads (41) and a 1.8, 2.0, 2.2 mm thick steel chassis (42).

The axle of the reverse gear intermediate wheel (51, Figure 3.13), the adjusted headland and the rear face of the gear box shall be prevented from drying out and rotating by the same plate (50) as the axle of the wheel assembly in their respective seats.

Gears I and II are achieved by connecting the gear clutch of the synchroniser (18) to the wheels (19) or (16) of the slip-fitted main shaft, which are permanently intermeshed with the co-operating intermediate gear units (44). Gear III is obtained by connecting the sliding clutch of the synchroniser (13) to the gear wheel (15) on the main shaft, like the gear wheels. The reverse E is achieved by connecting the intermediate wheel (52) to the wheel (18) mounted on the main shaft and the corresponding wheel to the gear unit (44).

All gearboxes except reverse gears are helical gear wheels.

■ The gearbox housing (20, Fig. 3.5), cast in grey cast iron, in the front and rear faces of the shaft bearing seats and the spindle holes for the clutch shaft rear bearing, has a diameter of $62^{+0.018}$ mm on the axles of the intermediate wheel assembly and the rear intermediate wheel b a diameter of $19{,}05^{+0.025}$ mm. Distance between the clutch shaft axle (the main axles of the intermediate wheel assembly are $74{,}6^{+0{,}08}$ mm and the intermediate wheel and intermediate wheel assembly axles $52{,}375^{+0{,}08}$ mm). The gearbox housing is screwed on and sealed with a cardboard seal or an asbestos rubber cover:

- cast iron coupling shaft bearing cover (1, Fig. 3.13),
- cast iron main shaft bearing cover (24, Fig. 3.13),
- aluminium alloy side cover (31, Fig. 3.13).

■ The coupling shaft bearing cover (1, Fig. 3.13) has a flange outer diameter (locating pin in the hole of the coupling housing) measuring $116^{-0.010}_{-0.050}$ mm. The diameter of the extended front cover, which is the guide of the impression bearing sleeve, is $44^{-0.075}_{-0.115}$ mm. internal for the coupling shaft journal, 35.18 mm. A right-hand spiral grease nipple (labyrinth) with a groove width of 3 mm and a depth of $0{,}5^{+0{,}1}$ mm is cut into this diameter; the pitch is 6 mm.

■ The main shaft bearing cover (24, Fig. 3.13) is made of grey and has a hole of $68^{-0.04}_{-0.10}$ mm in diameter for the sealer and $24^{+0.033}$ mm in diameter for the speedometer drive shaft. On the inside diameter of $42^{-0{,}34}_{-0{,}17}$ mm, cooperating with the flange end, the cut left-hand thread plate (0,5 ± 0.15 mm), which serves as a sealing lab here.

■ The side cover (31, Fig. 3.13) has a $40^{+0{,}05}$ mm diameter socket in the outer cylindrical overflow body for fixing the sleeve (tap selector ball joint) and $13^{+0{,}043}$ mm diameter holes in the inner projections (rib shape) with horizontal axes, 20 ± 0,1 mm apart (for taper roller bearing). In a larger

dome, perpendicular to the axis of holes, two-stage otv with diameters of $8^{+0.3}$ mm and $9{,}50^{+0,130}_{+0,040}$ mm are made for ball and negative snap fasteners with diameter of $9{,}5^{+0,130}_{+0,040}$ mm for locking balls and pins.

Definition	Dimensions, mm
Front bearing journal diameter (in coupling shaft)	19,991...20,000
Diameter of the rear bearing journal (in the rear face of the housing)	29,979...30,000
Multi-ply spline on the shaft:	
- outer diameter	29,979...30,000
- inside diameter	25,98...26,50
- number of appearances	6
- thickness of projections	7,82...7,87
Shaft length	285

3.9. Table: ESSENTIAL DIMENSIONS OF THE GEARBOX A13.1 MAIN SHAFT

■ The coupling shaft (7, Fig. 3.13), made of alloyed steel, is machined to a depth of 0;18 mm and hardened from the gear to the journal of the rear bearing. The basic dimensions of the clutch shafts are given in Table 3-4. A friction cone with a forming angle is lapped in conjunction with the ring of the synchronizer so that the lateral planes are 0.8...1,35 mm.

■ The main shaft (9, Fig. 3.13) made of alloyed steel is hardened to a hardness of 48... 55 HRC. Its main dimensions are given in tables 3-9.

Definition	Wheel				
	fixed gear	gear III	gear II	gear I	reverse gear
Number of teeth	29	30	22	17	15
Diameter of the indexing wheel	98,336	82,753	65,579	49,443	47,625
Angle of thrust (normal)	16°30’	20°	20°	20°	20°
Angle of inclination of the tooth screw line (on the indexing roller)	35°55’	25°	35°	19°	0°
Direction of inclination of the tooth screw line	right	right	right	right	straight
Tooth ring width	18,5 mm	17,0 mm	17,5 mm	18,0 mm	17,0 mm
Interdental clearance in pairs of cooperating wheels	0,1...0,2 mm				

3.10. Table: GEARBOX A13.1 CHARACTERISTICS

■ The flange end of the main shaft (47, Figure 3.13), forged from higher quality structural steel, is dimensioned:

- a pin cooperating with a sealant $42_{-0.10}$ mm,
- spline to be fixed on the main shaft: diameter of the bottom of the notches 30.026...30.077 mm; width of notches 7, 899...7.950 mm.

■ The axle of the front wheel assembly (47, Figure 3.13) shall be made of alloy steel. The diameter at the roller bearing seat is $19{,}05_{-0.012}$ mm. The axle is carburised to a depth of 0,9...1,2 mm and hardened.

■ The axle of the reverse gear intermediate wheel (51, Fig. 3.13), made of higher quality structural steel, shall have an outside diameter of $19{,}05_{-0{,}012}$ mm. It is surface hardened to a depth of 1,5...2 mm.

■ The gear set of the intermediate shaft (44, Fig. 3.13), made of alloy steel, is cyanated to a depth of 0.18 mm and hardened. The diameter of the holes for roller bearings is $28{,}575^{+0.025}$ mm. The characteristics of the gear unit are given in Table 3-10.

■ The gear wheel 1st gear (19, Fig. 3.13), mounted on the main shaft like the gear wheels 3rd and 2nd gear, made of the same alloy steel, has 33 teeth with the left direction of the inclination of the screw line. The diameter of the indexing wheel is 95,979 mm. The angles of thrust and tilt of the tine screw line are the same as those of the 1st gear in the intermediate shaft gear unit.

The synchronizer gear hub and the internal bore diameter for the sleeve have the same dimensions as the 2nd and 3rd gear gears.

■ The gear wheel in gear II (16, Fig. 3.13) is made of alloy steel and has 27 teeth with a left-hand inclination of the screw line. The diameter of the indexing wheel is 80,484 mm. The angles of thrust and tilt of the screw line are the same as those of the 2nd gear in the gear set of the intermediate shaft. The synchroniser gearbox and the inner diameter are the same dimensions as the third gear.

■ The gear wheel in gear III (15, Fig. 3.13), which is mounted on the main shaft by means of a slide sleeve (17) and is made of alloy steel, has 23 teeth with a left-directional inclination of the screw line. The diameter of the spur gear is 63,466 mm. The angle of thrust and the inclination of the input line are the same as those of the gear wheel III in the gear unit of these intermediate shafts. The synchronizer's pinion has the same dimensions as the coupling shaft wreath. The internal diameter of the hole for the sleeve is 40+0.009+0.025 mm.

■ The rear gear wheel on the main shaft (18, Fig. 3.13) S has 29 straight teeth and is also used as the sliding clutch of the synchroniser for the first and second gears. The diameter of the index 1 shall be 92,075 mm and the angle of thrust shall be 20°. In the hub there is a fork groove on the outside, excluding the following dimensions: outer diameter 82 mm, inner diameter 72 mm, width $8{,}5^{+0.09}$ mm, and on the inside - a multi-screw (compatible with the synchronizer hub) with 30 teeth pinned on the diameter 62,30 mm.

■ The steel backstop (52, Fig. 3.13) has 18 straight teeth in the one hundred inputs. The diameter of the indexing wheel is 57,277 mm and the angle of thrust of the indexing wheel is 57,277 mm, as in the wheel on the main shaft. This wheel is mounted daily as the reverse gear intermediate wheel in gearbox 16 on a bronze gearbox with an inner diameter of $19{,}075^{+0.025}$ mm.

■ The bearing sleeve (17, Fig. 3.13) for the gears on the main shaft is made of alloy steel and nitrocarbonate to a depth of 0.5 and has an anti-shortening phosphate coating on the outer diameter of $40^{-0.040}_{-0.075}$ mm with 34 screw grooves for easy lubrication of the contact surfaces. The inner hole

of the sleeve is: ended on one side (to be fixed on the main shaft) with a polygon stem with six notches of $7{,}95^{+0.1}$ mm width and threads: external $30{,}5^{+0.2}$ mm and internal $27{,}5^{+0.2}$ mm.

Synchronizers

The basic differences are in the design of the stones (28) and in the arrangement of the stones in the sliding clutch by means of the expansion shade rings (29) and the projections on the outer surfaces of the circumferential grooves in the grooves in the inner groove of the sliding clutch. The operating principle of the synchroniser is the same as that of the synchroniser in gearbox 16 (see chapter 3.1.1).

The internal gearshifting mechanism of box A13.1 (n 3.13) consists of the tap selector (33), three tellers (58, 59, 60) with videoclips (2, 11, 12) and the locking and unlocking device of the cross-section D-D shown. The selector is identical in design and bearing and the tap selector in gearbox 16. the waxes (58, 59, 60) are sliding in the bearing supports of the side cover. Forks I and II and the reverse of the gear are welded to the chiefs, and forks III and IV of the gear are fixed on the chief by means of a pin (57). The position of the lead (fork) is determined by the ball locks (56, 61) and the locking pin (62). Figure 3.13: In the neutral position of the outer lever m of the selector shifting mechanism, the lower ends of the selector (33) can be moved in a plane perpendicular to the longitudinal axis in the wild boar and the travel is limited by the resistance surfaces of the seat in the hydrant Il of the gear and in the fin of the end v of the reverse gear, after the resistance of the stopper has been overcome (54).

To switch on and to run, the lever of the external gear-switch connection mechanism must be moved in the direction of the driver's seat and forwards (in the direction of travel). During these movements the lower end of the tap selector enters the rectangular seat of the index head (60) and then the axial shift of the fork (2) and the sliding clutch of the synchronizer (18) takes place until the ring on the wheel (19) is fully interlocked with the ring on the 1st gear. The axial movement of the hydrant (60) causes locking with the balls (61) and the pin (62) of the hydrides (58, 59) in the natural position and locking with the ball catch (56, 61) in the notch of the hydride (60) in the first gear position.

Actuation Gear quantity is engaged in the same way, but the outer lever of the gear-shift mechanism must be moved from the neutral position in the direction to the driver's seat and back (opposite to the direction of travel).

Activation of the third gear is achieved by moving the outer lever of the gearshift control from the neutral to the forward position. In the transmission of the motion to the sliding clutch of the synchronizer (13) a guide (59) and forks (11) are used. The locking pin (62) remains in the centre position of the stem (59), the locking balls (61) in the sockets of the forks of the fork and the reverse gear and the ball catch (56, 61) of the stem (59) in the third gear.

■ The fork tips I - II, III - IV and reverse are made from the same grade of material and have the same diameters as the gearbox type 16. The sockets for the retaining and unlocking device components and the lower tap selector end compartment are also of the same dimensions.

■ Forks I and II (2, Fig. 3.13), forged from higher quality structural steel, are cyanated to a depth of 0,3 mm, hardened and phosphated. The fork arms are $8_{-0.2}$ mm thick and internally machined to

$72{,}4^{+0.2}$ mm diameter, with the centre of the wheel $64^{+0.1}$ mm from the hub axle and reduced by 20-01 mm with respect to the hub axle. The active arm length is 20 mm. The diameter of the hub hole is $13^{+0.015}_{-0.012}$ mm.

■ The 3rd and 4th gear forks (11, Fig. 3.13) are made of the same grade of material as the 2nd gear Lill forks and have the same arm thickness and diameter as the synchronizer's sliding clutch, but are located in the hub axis with a hole of 4 mm diameter per retaining pin on the rod.

■ The forks of the reverse gear (12, Fig. 3.13) are made of the same material as the forks of the 1st and 2nd gear. The $6{,}5^{-0{,}2}$ mm fork arms are machined from the inside at a diameter of $26{,}4^{+0.2}$ with the centre of the wheel at a distance of $39_{-0.1}$ mm from the hub axle and offset from it by 18_{-01} mm.

The external shifting lever is of the same design as gearbox type 16 lever and the operation and repair of gearbox A13.1 covers the same range of activities as gearbox type 16 and the sum of the interlocking clearances, when checked as for gearbox 16, should not exceed:

- Gear I - 3,6 mm
- Gear II - 3,9 mm
- Gear III - 4,2 mm
- Gear IV - 3,1 mm
- Reverse gear - 3,0 mm.

3.2.3 Polonez gearbox

The construction of four- and five-speed Polonaises car bodies is presented in Figure 3.14 and their technical characteristics in table 3-3. In the housing made of aluminium alloy there are installed three clutch (1), main (11) and intermediate shafts with a gear unit (13) and an axis of the reverse gear intermediate wheel (32).

■ The coupling shaft (1, Fig. 3.14) is mounted on the front in a ball bearing (6202AZZC3) mounted in the crankshaft, on the rear in a ball coupling (CBK-083) mounted in the front wall of both gearboxes. The shaft has a cut toothed gear ring fixed on the ring of the direct gear synchronizer.

■ The main shaft (11, Fig. 3.14) is mounted in a needle roller (CBK-112) in the front, in a coupling shaft, in a ball bearing centre (6306ANR) in the rear face of the gearbox bay and in a ball bearing in the rear (6206 for a four-speed shaft) or cylindrical (CBK-272 for a five-speed gearbox in the rear gearbox bay). The main shaft is fitted with I, II, UL and reverse gear drive wheels (also VI for five-speed gearboxes) and with 1-II, III-IV gear synchronisers (for five-speed gearboxes). At the end of the shaft are mounted (regardless of the type of box) the drive wheel of the gearbox quickly measures and the end of the flexible joint to connect to the drive shaft.

■ The intermediate shaft (13, Fig. 3.14), which is essentially a gear unit, is mounted in the front housing of the double row transmission housing of the ball bearing (CBK-075) and in the rear wall of the roller rugged housing (CBK-084w). In the five-speed box, the journal of the extended intermediate shaft is supported by a cylindrical roller bearing (CBK-273) in the rear cover.

3.2.3 Polonez gearbox

The axis of the reverse gear intermediate wheel (32, Figure 3.14) is determined by the rear face of the gearbox housing.

The drive from the clutch shaft is transmitted via the wheel set from the intermediate to the main shaft, in all gears with exception of gear IV, which is obtained by directly connecting the shaft to the main shaft with a sliding clutch synch of gear III and IV. All gearboxes except for reverse gear l have helical gearing wheels. The gearboxes are lubricated with gear oil. The overpressure, which creates the gearbox, is compensated with the atmospheric pressure by an air vent.

The basic differences in the construction of the Polo gearbox of boxes 16 and A13.1 result mainly from the adopted solution of the sync of low-pressure units (with external friction cone), the structure of which is shown in Figure 3.15, and the principle of operation in Figure 3.16.

Figure 3.16a shows the mutual position of the friction cones of the synchronizer shadow (1) and the sliding clutch shadow (2) and the position of the splines during speed alignment. By moving the sliding clutch in the direction of the arrow "d", the friction cones of the clutch (2) and the synchroniser ring are touched.

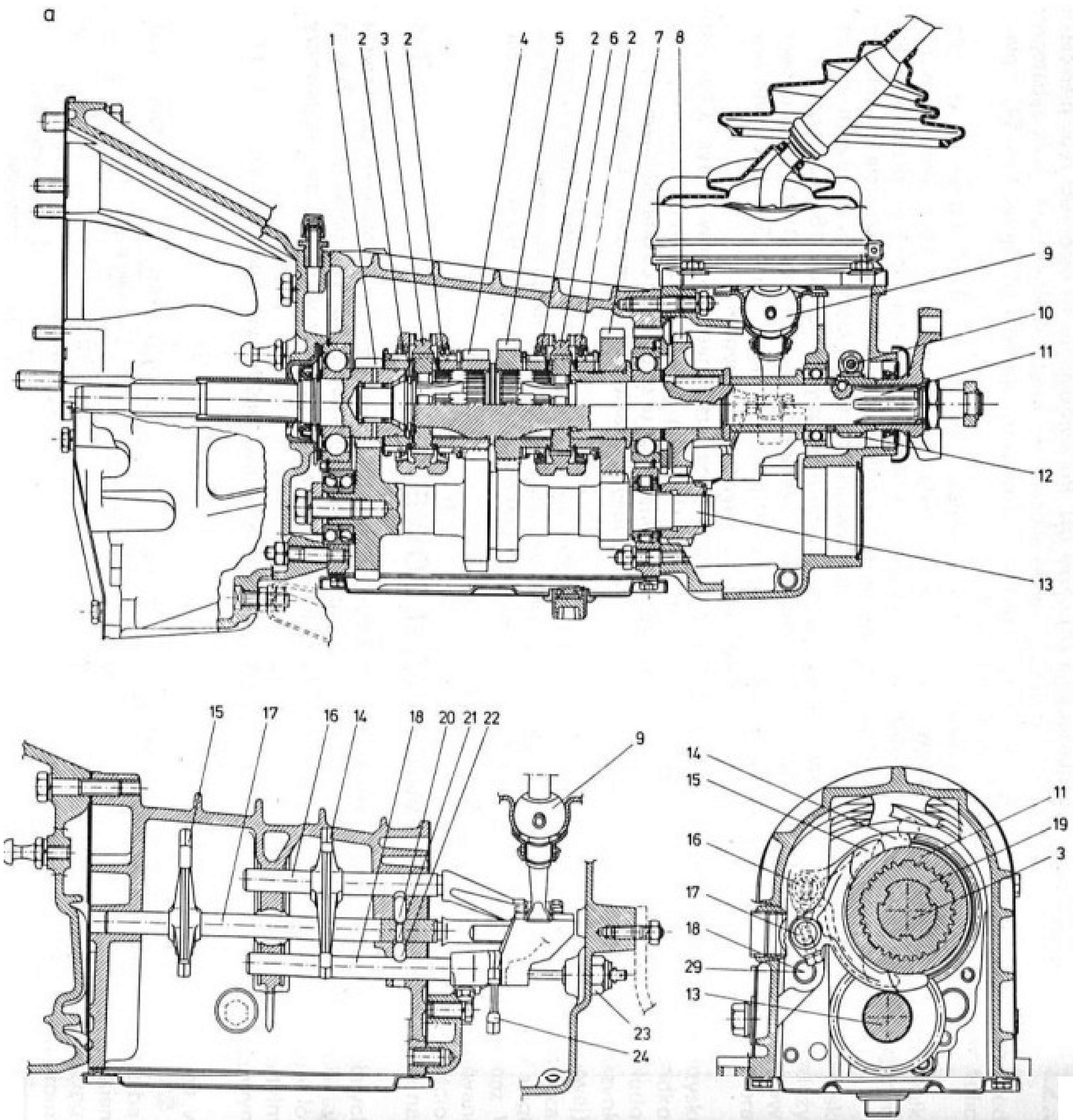
The circumferential friction force P causes the wheel (4), which is slid on the main shaft, to move angularly. Corpses of teeth of the following splines: v-shaped on the synchronizer ring (1) and external on it on the wheel hub (4) touch on the slopes (5) and remain in the position until the moment of force loss P, i.e. until the end of the period equalising the velocity of the sleeve (2) and the wheel (4). After the speed equalizes, the tines of the ring (1) slide diagonally into the recesses of the gear trough (4, fig. 3.16b) and behind them the coupling spline (2), connecting the wheel (4) with the synchronizer hub (3).

■ The fork-slide claws (1 in 3, Fig. 3.17) hold the sliding clutch in the engaged position. In order to prevent the automatic switching off of the gear, the sliding clutch is axially protected against the backdrop of the spline on the three shorter and thicker teeth of the synchroniser hub (3) by a peripheral support of the three teeth, as illustrated in Fig. 3.16b (Detail c).

■ The internal gearshift mechanism (Figure 3.18) shall be constructed and operate similarly to that of boxes 16 and A13.1.

■ The lever of the external gearshift mechanism (1, Fig. 3.19) is directly connected to the lever of the internal mechanism (4) and the passage in the floor of the driver's cab is sealed with a rubber cover (7). The operation of the gearbox shall be the same as for boxes 16 and A13.1.

Repairing the gearbox involves replacing worn or damaged components. The repair box shall comply with the technical conditions specified for gearboxes 16 and A13.1 in Chapters 3.2.1 and 3.2.2.

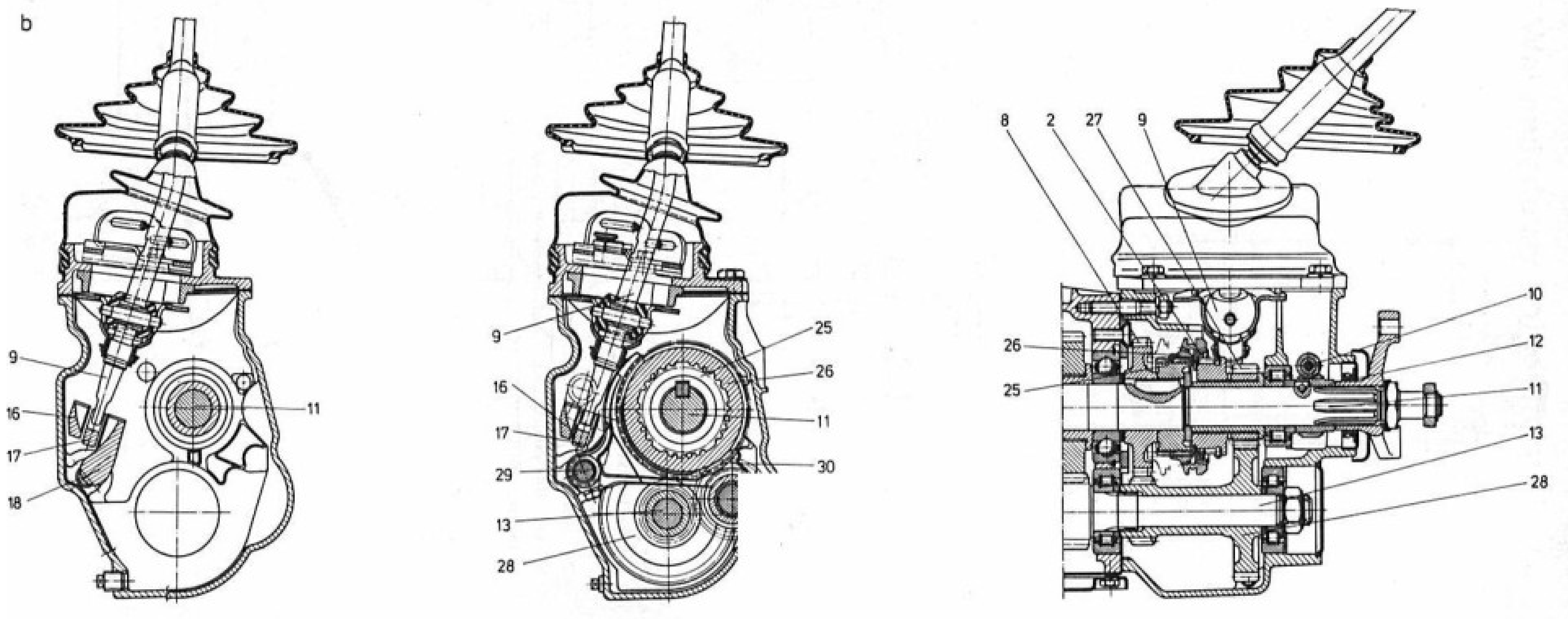


3.14. Figure: POLONEZ GEARBOX

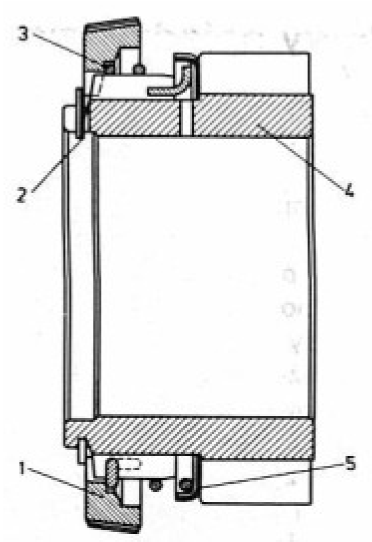
1 - clutch shaft, 2 - synchronizer ring, 3 - synchronizer shifting clutch, 4 - gear wheel, 5 - gear wheel, 2nd gear, 6 - synchronizer sliding clutch, 1 -|| gear, 7 - gear wheel, 8 - reverse gear toothed wheel, 9 - internal gear lever, 10 - gear wheel (driven) for speedometer drive, 11 - main shaft, 12 - gear wheel (driving) for speedometer drive, 13 - indirect shaft with gear unit, 14 forks, 15 forks, III and IV forks, 16 forks, 17 forks, III and IV forks, 18 forks, 19 forks, III and IV forks, 20, 21, 22 for locking collars, 23 for reversing light switch, 24 - forks for reverse gear, 25 - hub for synchronizer V gear, 26 - sliding clutch for synchronizer V gear, 27 - gear wheel V gear, 28 - gear set Vi reverse gear (five-speed box), 29 - fork lift???, 30 - ???? V and reverse, 31 - intermediate wheel for reverse gear, 32 - axis of intermediate wheel for reverse gear

1 - wałek sprzęglowy, 2 - pierścień synchronizatora, 3 - sprzeglo przesuwne synchronizatora III i IV biegu, 4 - kolo zębate III biegu, 5 - kolo zębate II biegu, 6 - sprzeglo przesuwne synchronizatora 1 i || biegu, 7 - kolo zębate I biegu, 8 - kolo zębate wstecznego biegu, 9 - dźwignia wewnętrzna zmiany biegów, 10 - kolo zębate (napędzane) przekładni napędu predkościomierza, 11 - walek główny, 12 - kolo zębate (napędzająco) przekładni napędu predkościomierza, 13 - walek pośredni z zespolem kół zębatych, 14 - widelki li ll biegu, 15 - widelki III i IV biegu, 16 - wodzik widelek li ll biegu, 17 = wodzik widelek III i IV biegu, 18 - wodzik widelek wstecznego biegu, 19 - piasta synchronizatora III i IV biegu, 20, 21, 22 - kolki ryglujące, 23 - wylacznik światla cofania, 24 - widelki biegu wstecznego, 25 - piasta synchronizatora V biegu, 26 - sprzęgło przesuwne synchronizatora V biegu, 27 - kolo zębate V biegu, 28 - zespól kół zębatych Vi wstecznego biegu (skrzynka pięciobiegowa), 29 - wodzik widelek ???, 30 - ???? V i wstecznego biegu, 31 - kolo pośrednie wstecznego biegu, 32 - oś kola pośredniego wstecznego biegu

3.2.3 Polonez gearbox



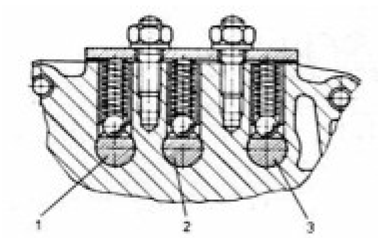
3.2.3 Polonez gearbox



3.15. Figure: POLONEZ GEARBOX SYNCHRONISER RING

1- chest synchronizer.
2 - breast sedimentary.
3- specific.
4- zebra wheel.
5 - spray seats

1- pierscien synchronizatora.
2 - pierscien osadczy.
3- sprezyna.
4- koło zebate.
5 - gniazda sprezyny



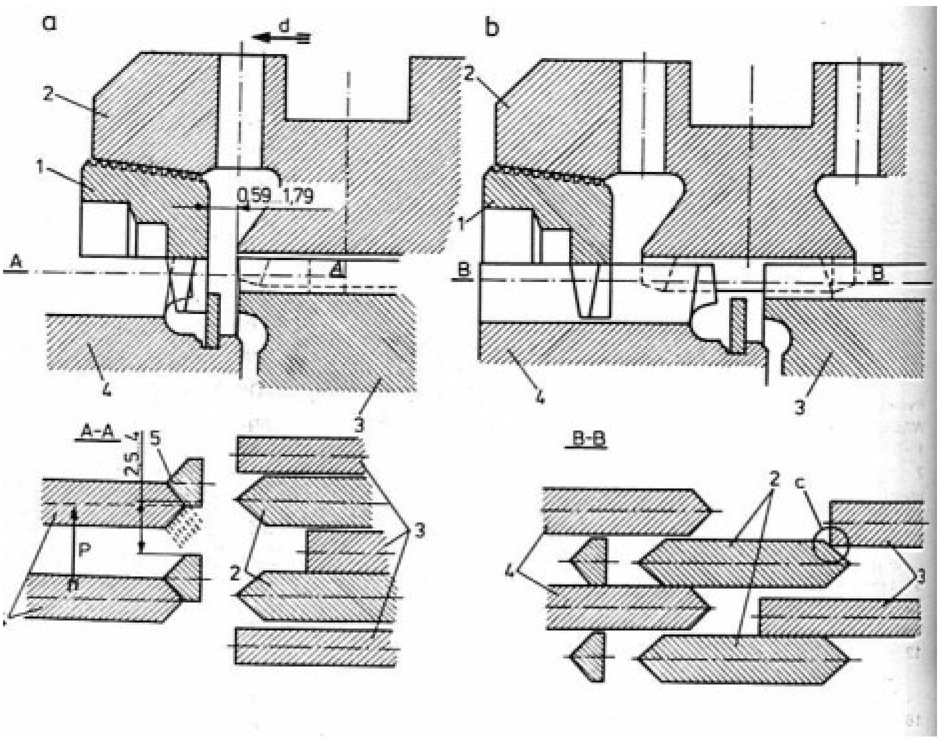
3.16. Figure: CAPTIVE SNAPS

1 - reverse gear fork selector,
2- fork drive, 1st and 2nd gear,
3 - fork arms III and IV

1 - wodzik widełek wstecznego biegu,
2- wodzik widełek I i II biegu,
3 - wodzik widełek III i IV biegu

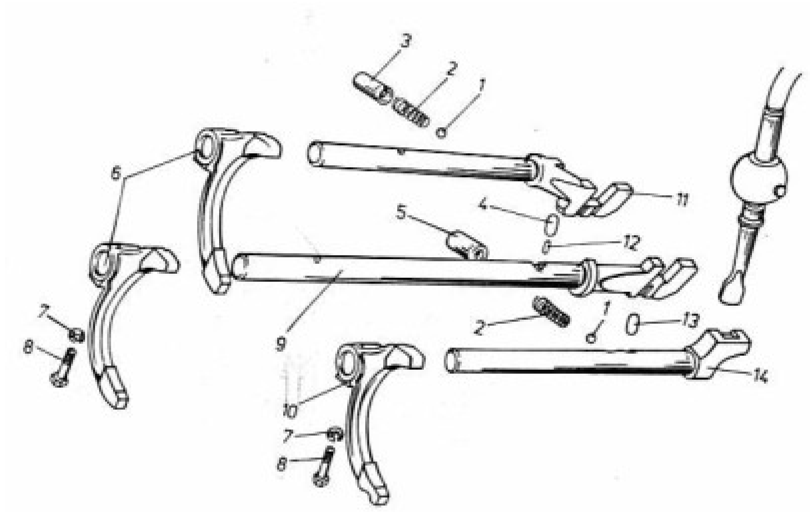
a - speed compensation, b - shifting on
1- chest synchronizer. 2- the distance has been reduced. 3 - Synchronizer hub. 4 - Gearwheel of switched-on gear unit, 5 - mitre cuts of the tines of the spline

a - wyrównywanie prędkości obrotowych,
b - włączenie biegu
1- pierscien synchronizatora.
2- sprzegio przesune.
3 - piasta Synchronizatora.
4 - kolo zebate właczanej przekladni,
5 - skosy czól zębów wielowypustu



3.17. Figure: PRINCIPLE OF OPERATION OF POLONEZ GEARBOX SYNCHRONIZER

3.2.3 Polonez gearbox



3.18. Figure: INTERNAL GEARSHIFTING MECHANISM

1- clip-on balls.
2 - click studs,
3,5 - sleeves.
4 - locking dowel fork I and ll fork I.
6- gearboxes I, II, III and IV
7 - washers
8 - Screws
9- the fork arms of the 3rd and 4th gear.
10 - V-shaped and reverse gear fork arms.
11 - fork arms for the first and second gears.
12 - locking pin for fork arms for the 3rd and 4th gear,
13 - dowel to lock the V-shaped fork and reverse gear.
14 - V-shaped and reverse gear fork arms

1- kulki zatrzasków.
2 - sprezyny zatrzasków,
3,5 - tulejki.
4 - kołek ryglujący wodzik widełek I i ll biegu.
6- widełki biegow I, II, III i IV
7 - podkładki
8 - sruby
9- wodzik widełek III i IV biegu.
10 - wodzik widełek V i wstecznego biegu.
11 - wodzik widełek I i II biegu.
12 - kołek ryglujacy wodzik widełek III i IV biegu,
13 - kołek ryglujacy wodzik widełek V i wstecznego biegu.
14 - wodzik widełek V i wstecznego biegu

3.3 DRIVE SHAFTS

3.3 DRIVE SHAFTS

The drive shaft is used to transmit torque from the gearbox to the rear axle main transmission. Two types of drive shafts are used in Żuk vehicles: single and split drive shafts. The technical characteristics of the drive shafts are given in Table 3-11.

Definition	Type of drive shaft	
	702	**14,6**
Type	single	divided with intermediate support
Length compensation Joints Maximum angle of articulation Maximum torque transmission (permanent) Test torque (with one shaft end stationary)	on a splined joint cross-braces with needle roller bearings 20 ° 560 N·m 1000 N·m	
Length in slip position	1565 mm	1575 mm
Permissible dynamic imbalance at 3600 rpm	0,245 N·cm	for each kilogram of the mass of the constituent shafts: 0,2 N·cm for each external support, 0.25 N·cm for the centre support
Angular clearance at 70 mm radius and static torque load 10 N·m	0,80 mm	1,16 mm
Lubrication: - cross joints - multi-pass couplings	Grease 1S grease ŁT4S2	
Weight	10,4 kg	11,6 kg

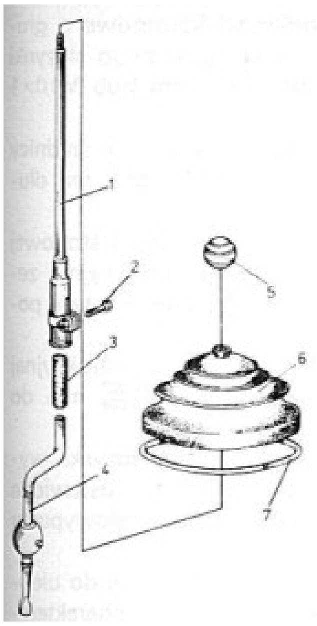
3.11. Table: TECHNICAL CHARACTERISTICS OF THE TRANSMISSION SHAFTS

3.3.1 Single drive shaft

The single drive shaft (Fig. 3.20) is a double articulated shaft with length compensation that can transmit torque up to 560 N·m.

The rear axle, suspended on semi-elliptical five-point springs, changes its position relative to the power train (engine with clutch and gearbox) both vertically and horizontally as the vehicle moves. The drive shaft connecting the two units is subject to similar displacements. Cross joints allow for angular deflection of the shaft and a splined joint for length compensation over a distance of 55 mm.

The use of hinges (on needle roller bearings) allows the shaft to swivel up to 20°, with the increase in the angle of deflection increasing the unevenness of their angular velocity. In order to minimise the angles of deflection of the shaft, throughout the working range of the rear axle, the drive unit and the rear axle are inclined in relation to the frame (in a vertical plane) so that, under static spring loads, the axles of the main gearbox shaft, the drive shaft and the main transmission drive shaft form a straight line. The length of the shaft in the retracted condition is selected in such a way that no folding angle exceeding the permissible values can occur in the hinges with maximum spring deflection.

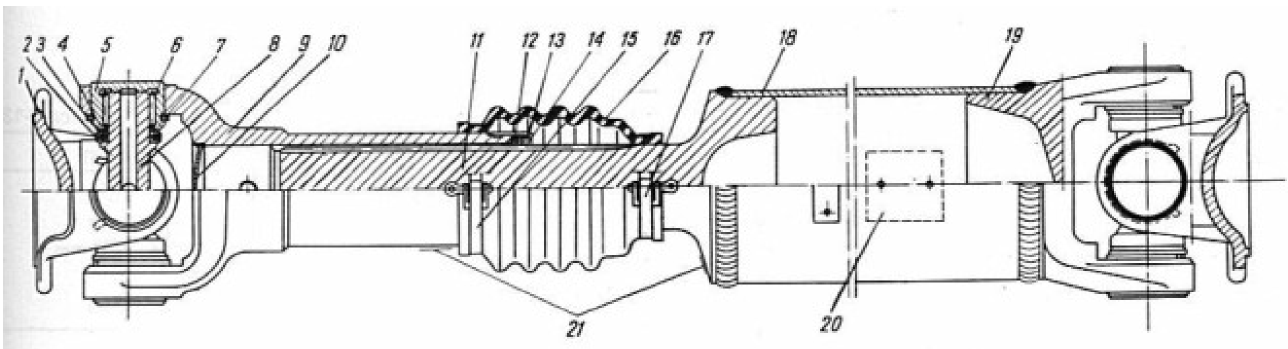


1 - rod of external gearshift mechanism. 2 - screw, 3 - damping sleeve, 4 - lever for internal gearshift, 5 - knob, 6 - rubber boot, 7 - elastic ring

1 - drążek zewnętrznego mechanizmu zmiany biegów. 2 - śruba, 3 - tuleja amortyzująca, 4 - dźwignia wewnętrznego mechanizmu zmiany biegów, 5 - gałka, 6 - osłona gumowa, 7 - pierścień sprężysty

3.19. Figure: GEARSHIFT LEVER

The drive shaft is dynamically balanced at 3600 rpm with an accuracy of 0,2 N·cm Larger imbalance is eliminated by the balancing plates (16) which are welded to the shaft pipe. After balancing, both drive shaft modules are marked with cracks, which must be aligned each time the shaft is removed and mounted. This is essential both to maintain the original equilibrium conditions and to ensure that the joints work evenly (the forks of the sliding end (9) and of the forked end (19) must not be at right angles to each other).



3.20. Figure: SINGLE TRANSMISSION SHAFT

1 - flange end, 2 bowls, 3, 4 - flange gasket, 5 - bearing outer ring. 6 - bearing needles, 7 - settling ring, 8 - joint diagonal. 9- sliding end, 10 - stopper, 11 - splined end, 12 - washer, 13 - felt gasket. 14, 15, 17 - Clamping clamps, 16 - splined joint cover, 18 - Drive shaft pipe, 19 - forked end, 20 - Balancing plate, 21 - Adjustment features

1 - końcówka kołnierzowa, 2- miseczka, 3, 4 - pierścień uszczelniający kpl., 5 - pierścień zewnętrzny łożyska. 6 - igiełka łożyska, 7 - pierścień osadczy, 8 - krzyżak przegubu. 9- końcówka przesuwna, 10 - zaślepka, 11 - końcówka wielowypustowa, 12 - podkładka, 13 - uszczelka filcowa. 14, 15, 17 - opaski zaciskowe, 16 - oslona złącza wielowypustowego, 18 - rura wału napędowego, 19 - końcówka rozwidlona, 20 - plytka wyważająca, 21 - rysy ustawcze

The shaft consists of a pipe (18) with welded ends: multi-spaced (11) and forked (19), sliding end (9), two flanged ends (1) and joint cross-braces (8) with needle roller bearings (5 and 6), fixed (in

the bifurcated holes of the shaft ends) by means of circlips (7). The bearings of the cross-braces are sealed with rubber seals (3, 4) and seals (2).

The shaft spline is sealed with a rubber washer (12) fixed with a clamping band (14). The joints are lubricated by grease nipples and axial hollows in the mallards, and the spline is lubricated by a grease nipple which is pressed into the front space of the sliding end (9), closed with a cap (10).

The drive shaft is mounted to the flange ends of the main shaft of the gearbox and the main drive shaft on eight M1?? screws via a 0,3 mm thick cardboard washer? (four for each connector).

■ The transmission shaft tube (18, Fig. 3.20), made of precision steel, with an inner diameter of $71^{-0,09}_{0,31}$ mm and a wall thickness of 2,1 ± 0,12 mm, shall have a visitor of 1219 ± 0,5 mm.

■ The splined end (11, Fig. 3.20), forged steel alloy for thermal upgrading, has an inductively rolled and hardened interior trapezoidal multilayer of 82 mm in length and the characteristics given in Table 3-12.

■ The forked end (19, fig. 3.20), forged from higher quality structural steel, has holes in its arms with a diameter of $30^{-0.007}_{-0.028}$ mm for the needle roller bearings. The bearing retaining ring spacing is $60^{-0.15}_{-0.11}$ mm. The axis of holes for needle roller bearings is set when assembling the pipe (welding) in the axis of symmetry of the teeth of the multidrive sliding tip.

Definition	Dimensions
Number of teeth	16
Diameter of the indexing wheel	$33_{-0,09}$ mm
Diameter of the tops of the teeth (outer)	$33,5-_{0,025}$ mm
Angle of crown of tooth	45°
Diameter of the rebate bottom	$30,0^{-0,4}$ mm

3.12. Table: MULTIPLE SPLINE CHARACTERISTICS OF THE DRIVE SHAFT END

Definition	Dimensions
Number of teeth	16
Diameter of the indexing wheel	33 mm
Diameter of the rebate bottom	$33,5^{+0,039}$ mm
Angle of support	45°
Diameter of the tops of the teeth	31 mm

3.13. Table: MULTI-PASS CHARACTERISTIC OF THE SLIDING END OF THE DRIVE SHAFT

■ The sliding end (9, Fig. 3.20), forged from alloy steel for heat dissipation, has an internal, multilayered trapezoidal joint of the contact character specified in Table 3-13. The arms are provided with holes for seating needle roller bearings, with the diameter and spacing of the surface of the bearings, as in the end of the forked pipe of the drive shaft (19, Fig. 3.20). The axis of the bearing holes lies in the plane of symmetry, passing through the notches of the spline. The blind hole (10, Fig. 3.20) has a diameter of 38+0.17 mm and an M6 thread for the grease nipple. The flange end (1, Fig. 3.20), forged from higher quality structural steel, shall have openings for needle roller bearings in its arms, as in the forked end of the transmission shaft (19, Fig. 3.2 and a sliding end (9, Fig. 3.20); it shall also have centering pins of 60 ± 0.25 mm diameter. The flange has holes with a diameter of 10,2+0.15 mm (for fixing screws).

■ The joint cross-braces (8, Fig. 3.20), forged from alloy steel, are poured in to a depth of 0.8...1.2 mm and hardened. The diameter of the linkage pivots shall be $17,46^{-0,01}$ mm and their height shall be $15,5^{+0,04}$ m.

The lubricating channels, drilled through the axes of the cross-brace, have a diameter of 6 mm. The central lubrication hole is ended with an M6 thread for the grease nipple.

■ The bearings of the cross-brace consist of an outer ring (5, Fig. 3.20) and 25 needles with a diameter of 2.5 mm and a length of 15.8 mm (6, Fig. 3.20). The outer ring and needles are made of bearing steel. The outer diameter of the outer ring is $30_{-0.009}$ mm and the inner diameter of the assembly (measured between the needles) is $17,48^{+0,033}$ mm. The groove for the settling ring, $3^{+0.4}$ mm wide, shall have a bottom diameter of 27,5 ± 0,1 mm.

■ The circlip (7, Fig. 3.20), made of spring wire, is hardened and phosphated. The rings are selected for thickness into three dimension groups: 2,430 mm, 2,465 mm and 2,500 mm. When mounting the shaft, the opposite bearing rings are selected from the same selection group.

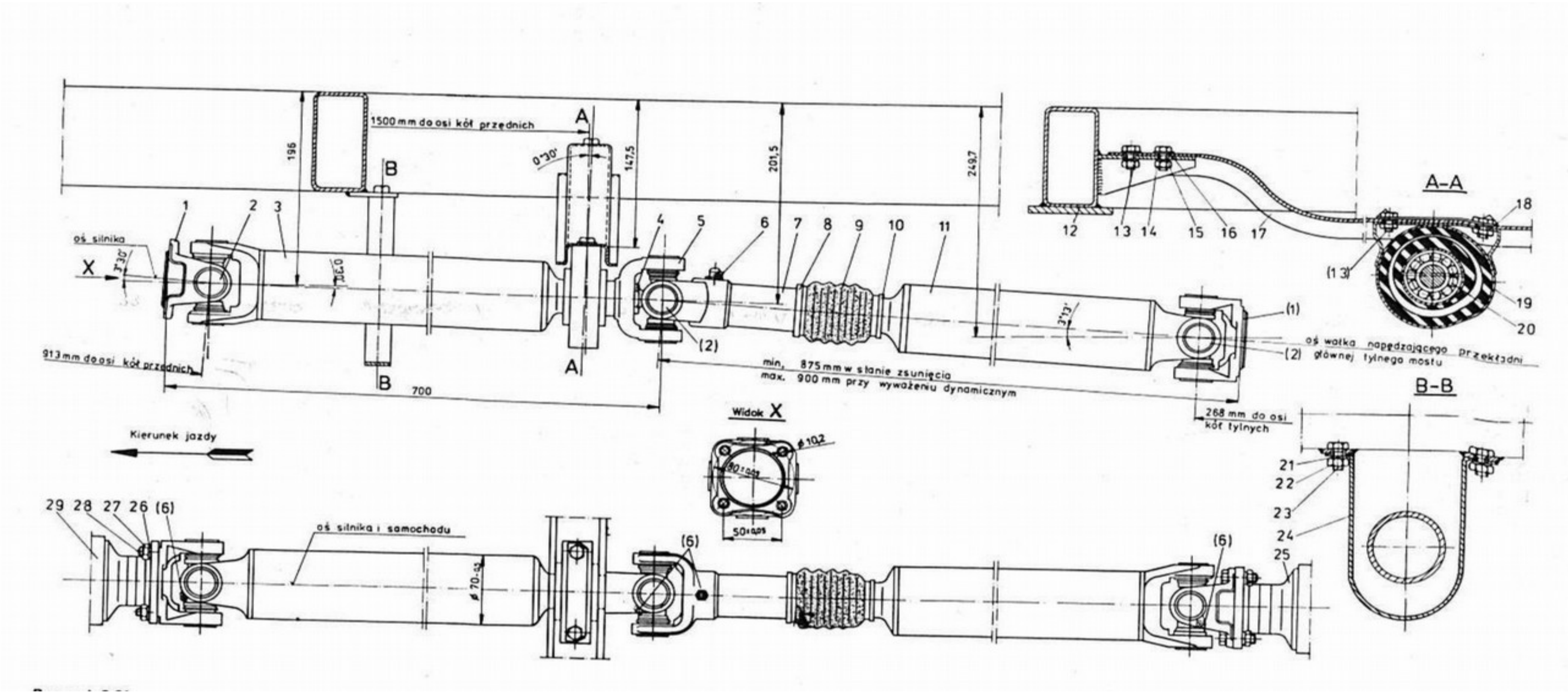
3.3.2 Split drive shaft

The split drive shaft (Fig. 3.21) is a unit of two single shafts: the front (3) and the rear (11). The front shaft is a single-joint shaft with an intermediate support (19), attached to the frame crossbar (17), and the rear shaft is a double-joint shaft with length compensation on the splined joint. The split drive shaft, which is complete, is semi-replaceable with the single drive shaft described in section 3.3.1 (after the frame has been adapted for mounting the crossbar of the intermediate support). The possibility of more precise dynamic balancing of the individual component shafts (shorter length) enables the reduction of vibrations in the drive train, which increases the durability of the drive shaft and the entire drive train.

The construction of the split shaft is shown in Figure 3.22. The front shaft with a pipe (10), 501 mm long, has two welded ends: a forked shaft (9) and a splined shaft (12). The forked end is pinned (Phillips joint) to flange end (1). The splined end is seated in the ball bearing (17) of the intermediate support and serves to fix the forked end (21) with a nut (20), secured against loosening by local creasing of its flange in intersections, made on the frontal plane of the end. The length of the front shaft, measured between the flange end contact plane (1) and the centre Pivot Axle, is 700 mm.

The flexible intermediate support consists of a sleeve (19) and a ring (16) with a vulcanised rubber insert (15). A hanger (36) for attaching an intermediate support to the crossbar of the car frame is attached to the ring by welding. The inner seating of the bushing (19) with a diameter of $52^{+0.029}_{-0.021}$ mm is used to determine the maintenance-free ball bearing type 62205 2RS (17) using the expansion ring (18). This bearing is protected against contamination by two discards (13) made of sheet steel. The rear shaft, with its length compensation on the splined joint, is constructed in the same way as the single shaft (described in section 3.3.1), except that its length is shortened to 875 mm (in the retracted condition). The latest shaft solution also introduces a single splined joint seal, identical to that of a single shaft.

3.3.2 Split drive shaft



3.21. Figure: CONSTRUCTION OF THE SPLIT DRIVE SHAFT

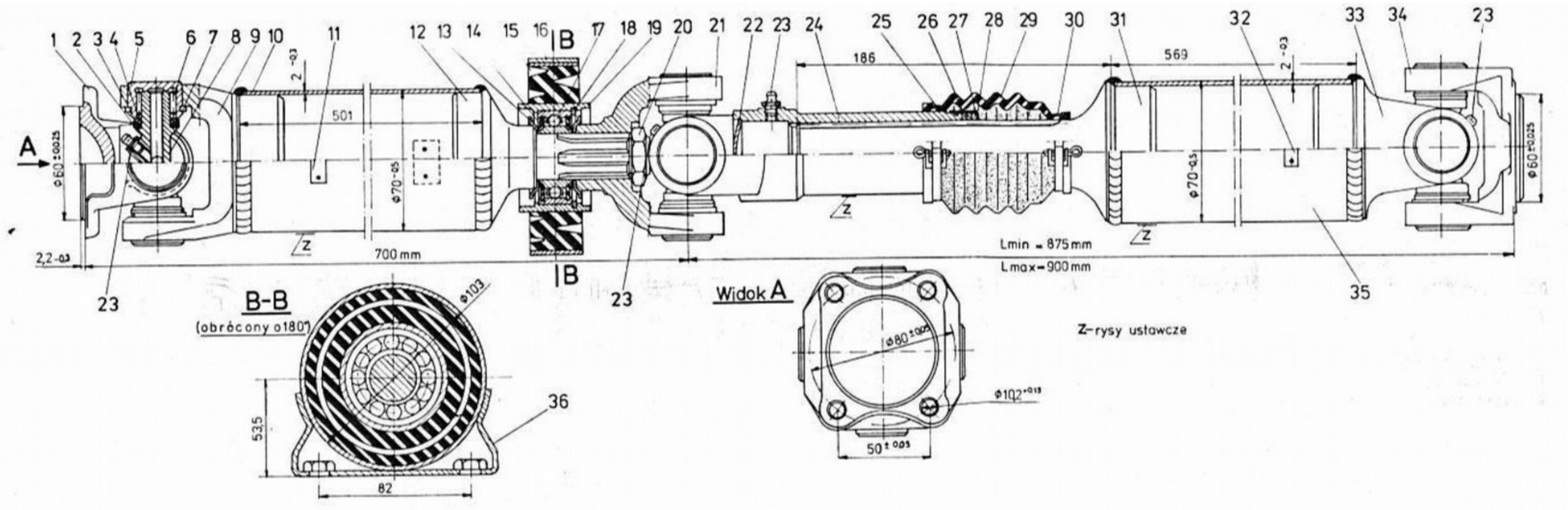
1- flange end
2 - a bush joint
3 - front roller
4,14, 22, 27 - nuts
5- fixed end forklift
6 - grease nipple
7 - sliding end
8, 10 - clamping clamps
9 - spline guard
11 - rear roller
12 - length of frame

13, 23,28 - screws
15, 21, 26 - spray pads
16 - washer
17 - front shaft support crossbar
18 - bent washer
19 - shaft support
20 - Ssupport bed
24 - clamps
25 - rear drive axle
29 - gearbox

1- koncowka kołnierzowa
2 - przegub krzyzakowy
3 - wał przedni
4,14, 22, 27 - nakretki
5- koncowka rowidlana stała
6 - smarowniczka
7 - koncowka przesuwna
8,10 - opaski zaciskowe
9 - osłona złacza wielowypustowego
11 - wał tylny
12 - podłuznica ramy

13, 23,28 - sruby
15, 21, 26 - podkładki sprezyste
16 - podkładka
17 - poprzeczka podpory walu przedniego
18 - podkładka odginana
19 - podpora wału
20 - łozysko podpory
24 - obejma
25 - tylny most napedowy
29 - skrzynka biegow

3.3.2 Split drive shaft



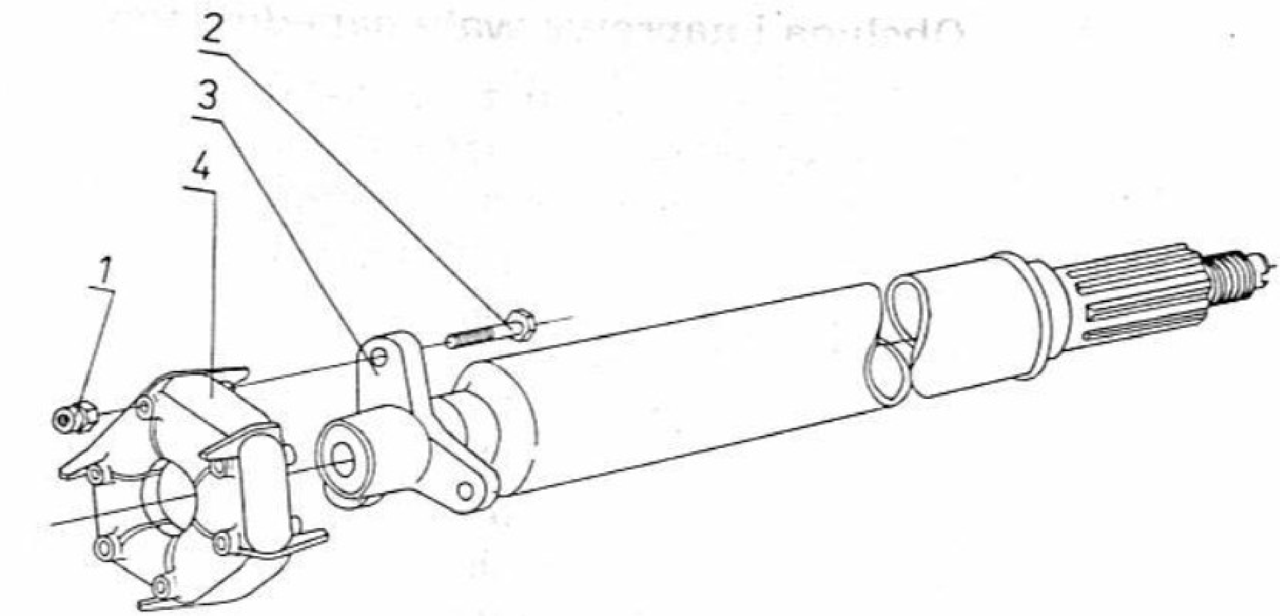
3.22. Figure: SPLIT DRIVE SHAFT

1, 34 - flange ends, 2 - bowl of sealing ring, 3 - sealing ring, 4 - closing ring of bearing, 5 - external bearing ring, 6 - bearing needle, 7 - settling ring, 8 - joint cross-brace, 9 and 33 - bifurcated ends, 10 - front shaft tube, 11 - balancing plate, 12 - multi-pass front shaft end, 13 - ejector, 14 - bearing seal, 15 - rubber system, 16 - support ring, 17 - ball bearing, 18 - expansion rings, 19 - support sleeve, 20 - nut, 21 - forked end of steel, 22 - cap, 23 - grease nipple, 24 - sliding end, 25 - forklifting, 1 - forklifting, 1 - forklifting, 2 - forklifting, 2 - forklifting, 1 - forklifting, 2 - forklifting, 2 - forklifting, 30 - compression clips, 26 - padding, 27 - felt gasket, 28 - gasket cover, 29 - splined joint cover, 31 - splined end, 32 - balancing plate, 35 - rear shaft tube, 36 - support hook

1, 34 - końcówki kołnierzowe, 2 - miseczka pierścienia uszczelniającego, 3 - pierścień uszczelniający, 4 - pierścień zamykający łożysko, 5 - zewnętrzny pierścien lożyska, 6 - igiełka łożyska, 7 - pierścień osadczy, 8 - krzyżak przegubu, 9 oraz 33 - końcówki rozwidlone, 10 - rura walu przedniego, 11 - płytka wyważająca, 12 - wielowypustowa końcówka walu przedniego, 13 - odrzutnik, 14 - uszczelka łożyska, 15 - uklad gumowy, 16 - pierścień podpory, 17 - lożysko kulkowe, 18 - pierścieni rozprężny, 19 - tuleja podpory, 20 - nakrętka, 21 - koncówka rozwidtona stala, 22 - zaślepka, 23 - smarowniczka, 24 - końcówka przesuwna, 25, 30 - opaski zaciskowe, 26 - podkladka, 27 - uszczelka filcowa, 28 - osłona uszczelki, 29 - oslona złącza wielowypustowego, 31 - końcówka wielowypustowa, 32 - plytka wyważająca, 35 - rura walu tylnego, 36 - wieszak podpory

3.3.2 Split drive shaft

The rear shaft tube (35), 569 mm long, is made of a steel tube, like the front shaft tube, with an outside diameter of 70 mm and a wall thickness of 2 mm. The active length of the spline is 63 mm, and length compensation is possible over a distance of 55 mm.

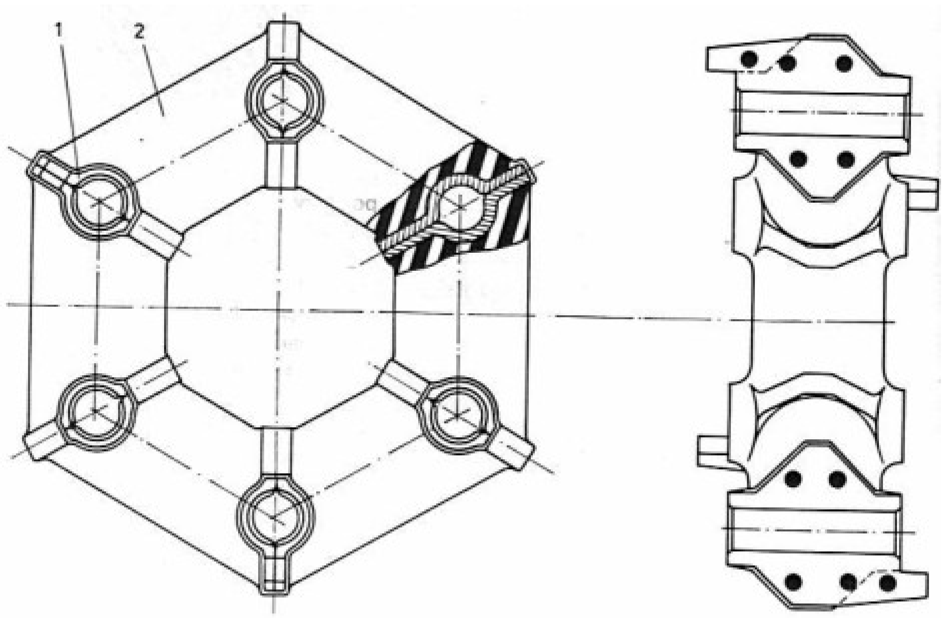


3.23. Figure: FRONT ROLLER WITH A FLEXIBLE JOINT

1 - nut, 2 - screw, 3 - front watt with tip, 4 - elastic joint

1 - nakrętka, 2 - śruba, 3 - wat przedni z końcówką, 4 - przegub elasty

The split drive shaft with a total mass of 11,6 kg is dynamically balanced at 3600 rpm. The permissible unbalance (for each kilogram of mass of the balanced shaft) is as follows: 0,02 N·cm for each outer support and 0,? N·cm for the centre stand. Greater imbalance is caused by welding the plates (11.32) to the front and rear shaft pipes. After balancing, the position of the detachable components of the split transmission shaft shall be rigid, marked by deep 0,3 mm drawings made in



1 - steel insert,
2 - rubber ring

1 - wkładka stalowa,
2 - pierścień gumowy

3.24. Figure: ELASTIC JOINT OF THE DRIVE SHAFT

the places shown in Figure 3.14. All alignment marks shall, each time the shaft is dismantled and assembled, be flush again so as not to affect the original balance lips.

The split drive shaft for cars in the "F" and "G" versions is designed to be fitted with the described shaft. The basic difference is that the flexible joint (4, Fig. 3.23) is used to connect the front shaft to the main shaft of the gearbox. This joint acts as a torsional vibration damper. It is (Fig. 3.24) a six-angular rubber ring (2) in which the steel insoles (1) used to connect the joint with the forked end of the gearbox and with the forked end of the drive shaft (for three M12x1.25 bolts each) are vulcanized. The fastening screws are tightened after the ring is pre-tensioned (the spacing of the holes in the free state is 10 mm larger than the spacing of the holes in the ends). The coaxiality of the parts to be connected is ensured by the centring sleeve, which is a component of the forked end of the drive shaft.

Maintenance and repair of the drive shaft

Drive shafts require no maintenance other than periodic lubrication of joints and splined joints and tightening of fixing screw nuts. During operation, attention must be paid to joint and spline clearances and to the possible occurrence of shaft run-out, causing the entire drive train to vibrate and knock when accelerating and braking the vehicle.

Permitted:

- angular clearance 0,8 mm for single transmission shaft and 1,16 mm for split transmission shaft (measured at a radius of 70 mm, with double-sided static torque loading of 9,81 N·m);
- cross-beam "beat" of shaft tubes 0,6 mm (measured perpendicularly to the axis of the pipe, excluding its ends at a length of 70 mm from the plane of connection with the ends). Typical disadvantages of the drive shaft, causes and method of repair are given in Table 3-14.

Repair of drive shafts is usually limited to replacement of riveted elements such as: joint cross-braces, needle roller bearings, splined bushes and elastic joints. Shaft members showing pipe twisting, bending or torsional buckling above the sizes given in Table 3-14 are not repaired, but replaced with new shafts. Before building a repaired dike for a car, the dike should be visible to the wife according to the rules specified in the following chapters.

3.3.2 Split drive shaft

1. Vibration and noisy operation during transmission	1.1 Excessive angular clearance of the roller (over and above the values given in Chap. 3.3.3).	1.1 Replace the drive shaft.
	1.2 Bent or kinked shaft tube (over 0,6 mm beat)	1.2 Straighten and dynamically balance the roller. Have the ASO or a repair shop carry out the repair.
	1.3 Worn or seized cross joints.	1.3 Replace the joints.
	1.4 Worn holes in flange fittings.	1.4 Replace the tips.
	1.5 Loosened bolt nuts for fixing the shaft flange ends.	1.5 Tighten the nuts with the required torque (Table 8-2).
	1.6 Defective assembly or installation of the shaft in the vehicle.	1.6 Set the shaft pipe and the sliding joint to scratch. When mounting, attach the shaft to the gearbox and rear axle coaxially on the centering pivots of the flange ends.
	1.7. unbalanced or defectively compensated drive shaft	1.7 Balance at the ATS or at the repair shop to the precision specified in Chapter 3.3.1 and 3.3.2.
	1.8 Lack of grease or inadequate grease in the joints.	1.8 Remove the hinges, clean them and lubricate them with the recommended lubricants. Replace damaged seals.
	1.9. intermediate support bearing damaged or worn.	1.9 Replace the bearing.
	1.10. Intermediate support rubber insert or flexible joint defective.	1.10. Replace the complete support u or the flexible joint u or joint.
	1.11. Loosened bolts for the attachment crossbar or for the hanger of the intermediate support.	1.11. Tighten the bolts.
	1.12. Excessive play in the dragonfly bearings of the main gearbox or the drive shaft of the main transmission.	1.12. Repair the gearbox or rear axle (see Tables 3 to 8 and 3 to 22).
	1.13. Damaged engine suspension components of the frame or drive bridge suspension.	1.13. Check and replace defective suspension parts.

3.14. Table: DRIVE SHAFT TROUBLESHOOTING

3.4 REAR DRIVE AXLE

The task of the drive bridge is to supply and distribute the nape to the rear wheels of the car. Rigid drive bridges are used in Żuk vehicles, as technical characteristics are given in Table 3-15.

Definition	Rear drive axle type			
	18	23	3005	3015
Type	rigid, with split main transmission housing		rigid, with uniform main gearbox housing	
Main transmission	single-stage, conical with arched teeth type Gleason		single-stage, hipoidal with arch teeth type Gleason	
Final drive ratio	5,125 (41:8)	5,86 (41:7)	4,778 (43:9)	
Differential mechanism	two-satellite with bevel gears with straight teeth Type Gleason			
Drive axles	loaded			
Permissible load	14000 N		16000 N	
Maximum input torque	460 N·m		550 N·m	
Torque test (with drive semi-axis immobilised)	1570 N·m		2500 N·m	
Wheels spacing	1375 mm		1375 mm	1530 mm ?????????
Lubrication:				
- main gearbox and differential	oil Hipol 15		oil Hipol 15 F[1]	
- propulsion semi-axle bearings	grease ŁT 43		oil Hipol 15 F	
Mass (with brakes)	84 kg		105 kg	

3.15. Table: TECHNICAL CHARACTERISTICS OF REAR DRIVE AXLES

3.4.1 Drive axle type 18/23

In the two-part (two-part) housing (13.24, Fig. 3.25) with half-welded seams pressed against me (26) there is a driving mechanism consisting of: a bevel-curve main gearbox, a two-satellite differential gearbox and a half-pivoting gearbox.

Main gearbox housing, firmly attached to the half seams, your carrying beam, attached to the car frame through the two semi-elliptical pen bars. The rear axle is a permanent unit (mileage to repair heads 90000...100000 km) provided that installation, particularly adjustment of bearings (clearance and preload) and toothed play, has been carried out with the requisite care and precision.

Main transmission

The Gleason single-stage bevel gear with bevel gear is designed to increase the torque transmitted from the drive shaft to the differential at a ratio of 5.125:1 or 5.86:1 and to transfer it at right angles to the drive semi-axis. It consists of a drive shaft (2, fig. 3.25), bearing on both sides in a double row tapered roller bearing (6) type GPZ-57707 and a spur roller bearing (45) type GPZ-102304, and a disc wheel (1) screwed to the differential housing (16) for ten bolts, jointly mounted on two tapered roller bearings (14) type 32210 A. The gear wheels of the gearbox are lapped in and selected in pairs for quiet running, as well as the size and arrangement of the tine interface. The kits are marked with a common serial number and the disc wheel (Fig. 3.26) shows the mounting

1 *Autoryzowana instruckjia napraw samochódow Żuk* (1992, p. 183) wrote: 1,1 dm^3 of Hipol 15 F based on ZN-71/MPCh/NF-73. For the record, Hipol 15 F is GL-5 SAE 85W-90 type.

position deviation of the drive shaft axle from the disc wheel fixing plane (42 mm dimensional deviation M).

■ The main gearbox housing is made of perlite cast iron in the form of two (13 and 24, Figure 3.25) separate shell castings reinforced with ribs and flanges. Both parts are connected in the split plane using eight M10x1 bolts.

The diameters of the sockets in the housing are as follows:

- for double row bearing $80^{-0.013}_{-0.050}$ mm
- for the spherical plain bearing of the drive shaft $50^{+0.03}$ mm
- on bearings for differential housing $90^{-0.024}_{-0.059}$ mm
- on half-track $75^{+0,046}$ mm

For filling or draining the housing, the walls are provided with two holes with tapered threads (B 1/2 inch) for the filler cap (for testing purposes at the same time) and for the drain plug. Ducts (46 and 47, Fig. 3.25) with a diameter of 6 mm each are used for lubrication of the double row drive shaft bearing.

■ The half-clips (26, Fig. 3.25) are made of a 76,1 x 4,5 mm steel tube. On the outside, they have steel flanges, welded together with seats $90^{+0.010}_{-0.025}$ mm in diameter, for semi-axis ball bearings and $72^{+0.10}$ mm in diameter for a rubber sealant (35). On the inside, the halfochemical pipes are machined to a diameter of $75^{+0.200}_{-0.025}$ mm, then pressed into the main gearbox housing and secured with three hole joints on the circumference.

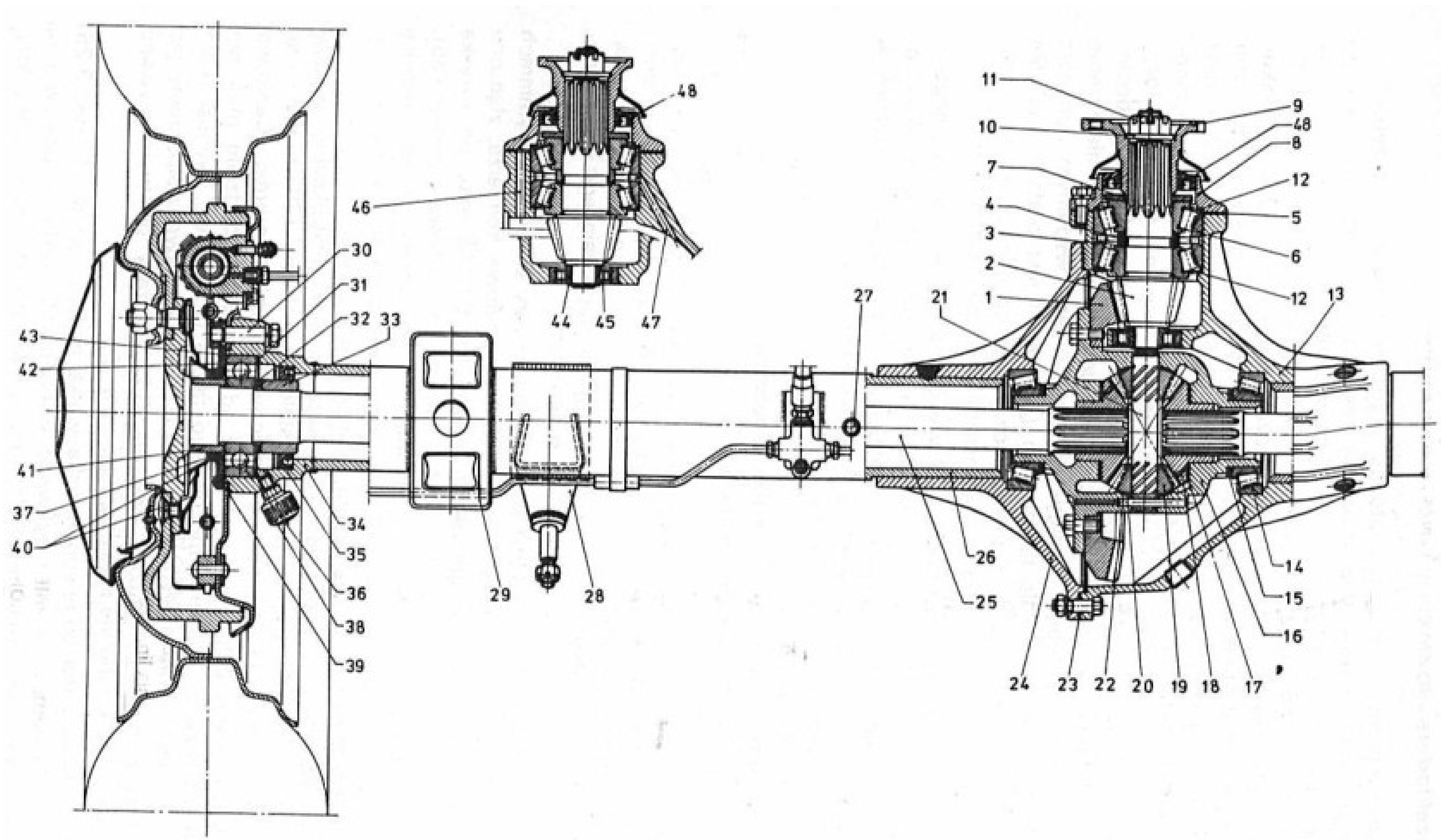
The spring cushions (29) and the steel supports (28) with pins $16^{+0.010}_{-0.019}$ mm in diameter for fixing the shock absorbers are welded to the half-cheats (forged from higher quality structural steel). The overall length of the left-hand half-track, measured from the plane of the housing division to the plane of the backing plate mounting flange, shall be 624,5 ± 0,5 mm and the right-hand half-track shall be 716,5 ± 0,5 mm. An air vent (27, Fig. 3.25) is fitted on the left semi-ridge to compensate the pressure in the main gear unit housing.

■ The cover of the double row drive shaft bearing (8, Fig. 3.25) is a black cast malleable cast iron. The socket in the sealant cover is $68^{-0.04}_{-0.10}$ mm in diameter, and $80^{+0.06}$ mm for the double row bearing washers. The flange has six evenly spaced $10.2^{+0.24}_{-0.06}$ mm holes for the screws that secure the cover to the main gear unit housing.

■ The main transmission drive shaft (2, Fig. 3.25), made of alloyed steel, is carburized to a depth of 1.1...1.4 mm (except for the spline and the threaded end) and hardened. The basic dimensions of the shaft are given in Table 3-16 and the toothed gear characteristics are given in Table 3-17.

■ The main gearbox disc wheel (1, Fig. 3.25), made of alloy steel, is carburized to a depth of 1.1...1.4 mm and hardened. The outer diameter of the wheel is 219,735 mm and the diameter of the hole to be fixed on the differential housing is $125^{+0,025}$ mm. The wheel centre has ten M10x1.25 threaded holes for the fixing screws. The tooth characteristics of the disc wheel are given in Table 3-18.

3.4.1 Drive axle type 18/23

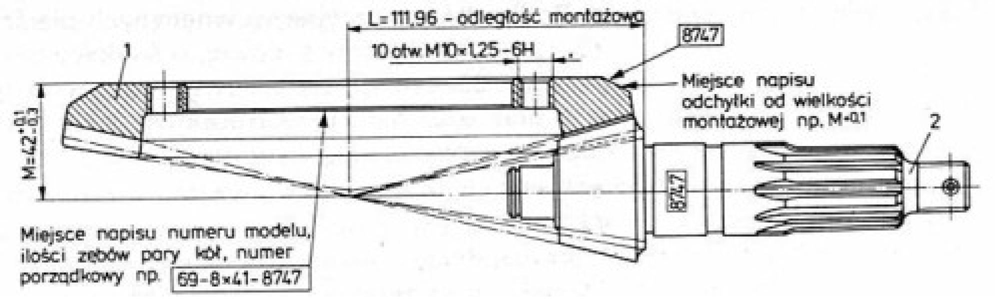


1 - koło talerzowe pradkładni głównej, 2 - walek napędzający przekladni głównej, 3 - podkladka regulacyjna wewnętrznych pierścieni lożyska dwurzędowego, 4 - tuleja odleglościowa wewnętrznych pierścieni łożyska dwurzędowego, 5- uszczezelka pokrywy lazyska dwurzędowego, 6 - dwurzędowe lożysko walka napędzającego, 7 - podkładka dociskowa łożyska dwurzędowego, 8 - pokrywa dwurzędowa lożyska wałka, 9 - kolnierzowa walka napedzającego, 10 - podkładka, 11 - nakretka koronowa,12 - podkładki regulacyjne zewnętrznego pierścienia lożyska dwurzędowego, 13 - obudowa przekładni głównej. 14 - lożysko stożkowe obudowy mechanizmu różnicowego, 15 - podkładki regulacyjne lożysk mechanizmu różnicowego. 16 - obudowa mechanizmu różnicowego 17 - podkładka oporowa koła koronowego. 18 - koło koronove, 19 - satelit mechanizmu różnicowego, 20 - podkładka Oporowa. 21 - sworzen satelitow 22. - ??? sworzen satelitow, 23 - uszczelka pokrywy obudowy przekładni głównej. 24 - pokrywa obudowy przekhadni głównej 25 - półos napędowa, 26 - połpochwa, 27 - odpowietrznik, 28 - wspornik mocowania amortyzatora, 29 - poduszka resoru, 30 - sruba, 31 - podkładka sprezysta plerscienia zewnętrznego łożyska półosi napędowej. 32 - pierscieh sprezysty wewnętrznego pierścienia łożyska półosi napędowej. 33 - pierscien mocujacy lożysko półosi napedowej. 34 - kolnierz potpochwy. 35 - ???, 36 - ???, 37 - uszczelniacz filcowy półosi napędowej, 38 - smarowniczka. 39 - wkret, 40 - odrzutnik smaru 41 - tuleja usczelniacza półos, 42 - osłona uszczelniacza lożyska półosi napędowej, 43 - plytka uszczelniacza łożyska pólosi napedowei, 44 - pierścień zabezpieczający lożysko wierzchołkowe Walka napędzającego.45 - lożysko wierzchołkowe walka napędzającego, 46, 47 - kanaly olejowe .48 - uszczelniacz walka napędzającego

3.25. Figure: REAR DRIVE AXLE

1 - disc wheel of the main gearbox, 2 - disc drive roller of the main gearbox, 3 - adjustment pad of the inner rings of the double row bearings, 4 - distance sleeve of the inner rings of the double row bearings, 5 - handles of the double row bearings cover, 6 - double row drive roller bearings, 7 - double row bearing washers, 8 - double row drive shaft bearings, 9 - collar drive roller, 10 - washers, 11 - crown nuts, 12 - adjustment washers of the outer double row bearing ring, 13 - main gearbox housing. 14 - conical bed for differential housing, 15 - adjustment washers for differential housing. 16 - Differential housing 17 - Castor washer. 18 - crown wheel, 19 - differential mechanism satellite, 20 - thrust washer. 21 - Satellite pin 22 - ? satellite pin, 23 - the gasket of the cover of the main gearbox housing. 24 - main gearbox housing cover 25 - drive semi-axis, 26 - half-shell, 27 - vent, 28 - shock absorber mounting bracket, 29 - spring cushion, 30 - bolt, 31 - external gearbox plummet washer. 32 - chest spray of the inner ring of the drive shaft bearing. 33 - a chest power-supporting box for the drive shaft. 34 - the collar of the poison. 35 - ??, 36 - ??, 37 - a felt seal on the drive shaft, 38 - a grease nipple. 39 - screw in, 40 - grease nipple 41 - semi-spherical seal sleeve, 42 - box seal sleeve, semi-spherical seal, 43 - box bearing plate, drive shaft, 44 - box securing apex ring Drive roller.45 - spherical drive roller, 46, 47 - oil channels, 48 - drive roller sealant

■ The spacer sleeve for the inner rings of the double row bearing (4, fig. 3.25), made of a steel pipe, has an inner diameter of $35^{+0.50}_{+0.34}$ mm, outer diameter of 45 mm and a thickness of $9.6_{-0.1}$ mm.



1 - drive shaft.
2 - disc wheel

1 - wałek napędzający.
2 - koło talerzowę

3.26. Figure: IDENTIFICATION OF THE MAIN TRANSMISSION WHEEL PAIR

Definition	Dimensions, mm
Diameter of spherical plain bearing journal	$20^{+0,030+}_{0,015}$
The diameter of the journal of the inner rings of the double-row bearing:	
- from the gear side	$35^{+0,025}$
- from the spline side	$35^{-0,010}_{-0,027}$
Multiple spline:	
- outer diameter	$31,7^{-0,077}_{-0,128}$
- thickness of projections	$4,9^{+0,024}_{-0,110}$
Shaft length	174,5

3.16. Table: MAIN DIMENSIONS OF THE DRIVE SHAFT OF THE MAIN GEAR UNIT

Definition	Dimensions (type 18)	Dimension (type 23)
Number of teeth	8	7
Diameter of the indexing wheel	42,748 mm	37,400 mm
Point angle	11°02’	9°41’20’’
Angle of support	20°	20°
Angle of tooth line inclination	40°	35°
Direction of tooth line inclination	left	left

3.17. Table: CHARACTERISTICS OF THE GEARWHEEL OF THE MAIN DRIVE SHAFT

Definition	Dimensions (type 18)	Dimension (type 23)
Number of teeth	41	41
Diameter of the indexing wheel	219,975 mm	219,057 mm
Point angle	78°58’	80°18’40’’
Angle of support	20°	20°
Angle of tooth line inclination	40°	35°
Tilt direction	right	right

3.18. Table: GEAR TOOTH CHARACTERISTIC OF THE MAIN GEAR UNIT DISC SPROCKET

■ The adjustment washers for the inner rings of the double row bearing (3, fig. 3.25) are made of steel strip with an outer diameter of 46 mm and a diagonal diameter of 36 mm and are manufactured in three thicknesses: 0,0 mm; ? mm and 0,25 mm. The selection of suitable washers allows the adjustment of bearing clearance and preload.

■ The adjustment washers of the outer bearing ring for the double row (12, fig. 3.25), made of manga-rich sheet steel, have an outer diameter of $80^{-0.2}_{-0.8}$ mm and an inner diameter of $73^{+0.4}$ mm. The rings are manufactured in six height dimensions (1.48...1.73 mm); they allow for adjustment of the toothed clearance of the main gearbox.

■ The pressure pad of the tapered double row tension roller bearing (7, Fig. 3.25) of elevated manga steel has an outside diameter of $67{,}4_{-0.1}$ mm and a thickness of $5{,}5_{-0.16}$ mm. The spiral groove, $2{,}2^{+0.2}$ mm wide, is cut into the water and serves as an oil rejector. The inner hole has a splined groove with a $31{,}7^{+0.05}$ mm groove bottom diameter and a $5^{+0.2}$ mm groove width.
■ The flange end of the drive shaft (9, Fig. 3.25), forged from higher quality structural steel, is 54 mm long. Cut-out end of internal spline, with groove bottom diameter 31,65...31,? mm and a notch width of 4.90...4.95 mm for securing the drive shaft. The journal, which cooperates with the sealant, is surface hardened (up to a depth of 2...2,5 mm) and polished, has an external average of 42-01 mm. The flange has four holes with a diameter of $10.2^{+0,??}_{-0,??}$ mm, for the fixing bolts on the drive shaft. The following is pressed onto the end: a spot-welded steel cover for the preloading shaft bearing seal.

■ Washer of the nut of the flange end of the drive shaft (1 Fig. 3.25), made of steel with increased content of manganese, outer diameter $34_{-0,4}$ mm, inner diameter $21^{+0,4}$ mm and thickness $4_{-0,16}$ mm.

Differential mechanism

The differential mechanism with tapered gears (fig. 3.25) consists of two satellites (19), pivoted on a pin (21) with a pin (22) in the housing (16) and two kroner (18), connected by splines with the propelling semi-axis (25). The differential crown wheels on the housing side of the mechanism cooperate with the thrust washers (17).

The differential mechanism enables the drive wheels to rotate on their own at different speeds, when driving on curves or on uneven roads and in a situation where each of the drive wheels of the car is on a different road in a time unit.

As long as both car drive wheels run at the same speed, the satellites remain wedged between the crown wheels and rotate, together with the pin and the differential housing, to transmit the power in the semi-axis. If the rotational speed of one of the drive wheels is reduced, the rotational speed of the crest wheel, which is coupled to it, decreases evenly. This launches the rotation of the satellites around the pin and increases the peripheral speed of the second crown wheel and the associated sprocket shaft. There is the following relationship between the speeds of the drive wheels: the speed of one wheel is reduced to the rear, and the speed of the other wheel is increased. The sum of the rotational speeds is constant and equal to double the rotational speed of the disc wheel (differential casing).
This principle also results in the drive wheels rotating in opposite directions with the differential housing immobilised.

The torque transmitted by the main gearbox is distributed by the differential mechanism evenly over the two drive wheels, irrespective of the rolling resistance of each. If one slip occurs (due to

the loss of adhesion to the ground), the driving force developed by the wheel is very small. The second wheel, which has good grip, stops because, in accordance with the principle of equal torque

distribution (equal driving forces on both wheels), the power developed on it will be equally small and not sufficient to drive the car.

The wheel, which is in slippage, rotates at double the speed of the disc wheel (differential casing), which can cause the differential to seize if you try to start your car for a longer period of time.

■ The differential housing (16, Fig. 3.25) is a thick-walled perlite cast iron housing. The flange, 178 mm in diameter and 9 ± 0,2 mm thick, reinforced with ten ribs, shall have holes of $10^{+0,2}_{+0,1}$ mm in diameter for the wheel fixing screws (M10 x 1,25).

The fixing diameter of the disc wheel centre is $125^{+0.030}_{+0.004}$ mm. A window measuring 83x68 mm shall be cast into the side of the housing, having a diameter of 118 ± 0,1 mm, through which the differential bevel wheels shall be mounted.

The sockets in the housing have the following diameters: for the journal of the crown wheels $42^{+0.039}$ mm, for the satellite pin $20^{+0.013}_{-0.010}$ mm, for the pin securing the satellite pin $6.1_{-0.1}$ mm.

The skid bowls of the satellites are spherical in shape with a ball diameter of $97^{+0.1}$ mm (with the centre located at the intersection of the main gearbox's gear axes). The distance between the faces of the wedge ring washers is $66^{+0.16}$ mm.

The differential housing is supported in the main gearbox housing. The bearing journal diameters are $50^{+0.030}_{+0.010}$ mm and the plane spacing of the tapered roller bearing thrust washers is $135^{+0.05}_{-0.20}$ mm.

■ Crown wheels (18, Fig. 3.25) made of alloy steel are carburised to a depth of 1,1...1,4 mm, hardened and phosphated. Their outer diameter is $81_{-0.2}$ mm. The diameter of the kingpin for mounting the crown wheel in the housing is $42^{-0.050}_{-0.075}$ mm.

The characteristics of the serration of the crank gears are given in Table 3-19, and of the volute spline for connection to the hemispheres are given in Table 3-20.

The lubrication (reduction of friction) of the crown washers is carried out via two oil channels with a diameter of 3 mm, made in their interlocking notches.

■ The satellites of the differential mechanism (19, Fig. 3.25) are made of the same material as the crown wheels. The outer diameter of the satellites is $55,4_{-0,17}$ mm and the diameter of the pin hole is $20^{+0.105}_{+0.060}$ mm.

The dentition characteristics of the satellites are given in Table 3-21, where the resistance planes of the satellites (for use with slide primers) are embedded in a 47,80 mm sphere.

Number of teeth Diameter of the indexing wheel Point angle Angle of support	16 80,0 mm 58° 22°30'

3.19. Table: TOOTH CHARACTERISTICS OF THE CROWN WHEELS OF THE DIFFERENTIAL MECHANISM

Number of teeth Diameter of the indexing wheel Angle of support	30 pcs. 30 mm 30°

3.20. Table: CHARACTERISTICS OF THE REVOLVING MULTI-PULLEY OF THE DRIVE AXLES AND THE DIFFERENTIAL CROWN WHEELS

Number of teeth Diameter of the indexing wheel Point angle Angle of support	10 50,0 mm 32° 22°30'

3.21. Table: DENTITION CHARACTERISTICS OF THE SATELLITES OF THE DIFFERENTIAL MECHANISM

■ The satellite pin (21, Fig. 3.25) made of alloyed steel is carburised to a depth of 1.1... 1,4 mm, hardened and phosphated. The outer diameter of the pin shall be 20 ± 0,007 mm and its length $116_{-0,23}$ mm. The satellites are mounted on the surface of the pin with a 1 mm wide spiral lubricating grooves with the right direction of inclination of the lithium. The hole for the safety pin is $6.2^{+0.10}_{-0.05}$ mm in diameter.

■ Satellite pin (22, Fig. 3.25), made of higher quality structural steel, has a length of 52 mm and an average length of $6^{+0.016}_{+0.008}$ mm.

■ The satellite slip washers (20, Fig. 3.25) made of a higher quality poisonous horse statue are made in the form of spherical bowls (ball stud 47,8 ± 0,5 m) with a thickness of 0,72-004 mm. The pads are phosphated.

■ The wear washers of the crown wheels (17, Fig. 3.25) from the higher quality design stage have an outside diameter of 64 mm, an inside diameter of $42^{+0.34}_{-0.17}$ mm and a thickness of $1{,}71_{-0.04}$ mm. The pads are phosphated.

■ The differential bearing supports (15, Fig. 3.2) made of higher quality structural steel have an outer diameter of 68 m and an inner diameter of $50^{+0.70}_{+0.50}$ mm. The washers are made in four thicknesses: 0.1 mm, 0.15 mm, 0.25 mm and 0.5 mm, to allow for adjustment of the main gearbox interlocking clearance.

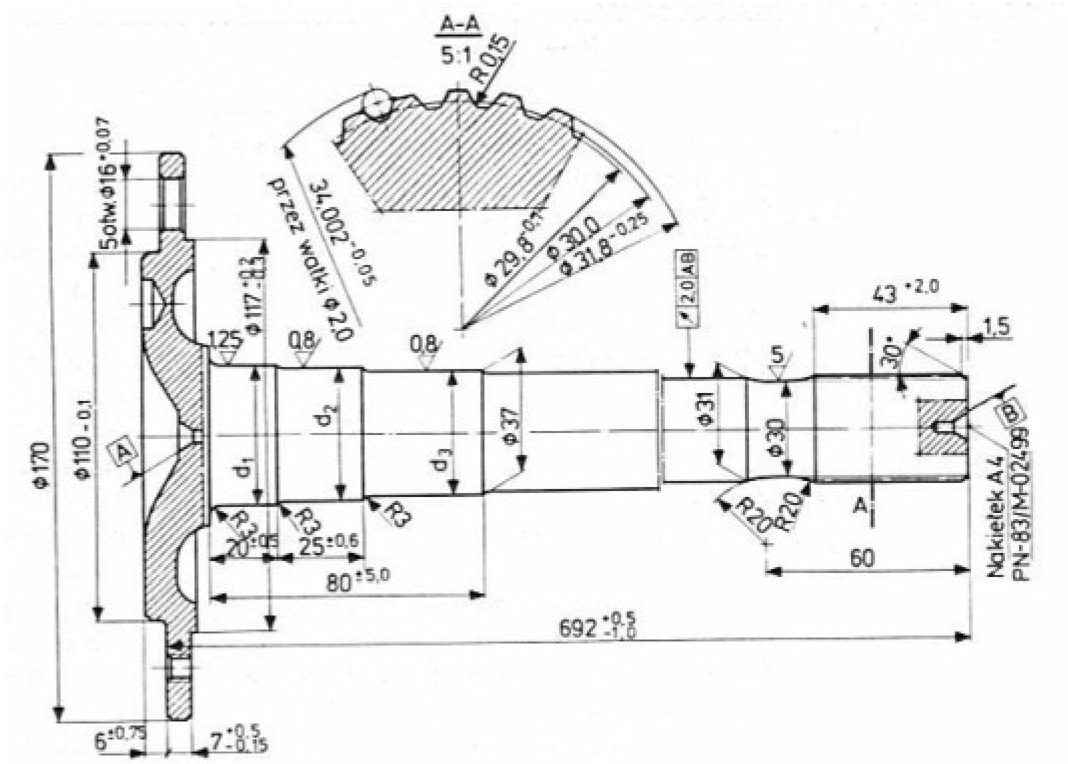
Drive shafts

Drive shafts (25, Fig. 3.25) of the loaded type are used to transmit the torque from the differential wheels to the drive wheels and the full bending moment from the reaction forces of the roadway. The hemispheres are supported in the drive bridge semi-joints on which the ball bearings (36) type 6308, the fixed axes are supported by the sealing plates (43) and the clamping rings (33) and the

compression rings (31 and 32). These bearings are lubricated (with rolling bearing grease) by grease nipples (38), made of plastic.

■ The drive axle of the rear axle (Figure 3.27), forged from alloyed steel for thermal upgrading, is terminated on one side (40^{+3} mm long) with a spline of the characteristics shown in Table 3 to Table 20, and on the other side with a flange with an outside diameter of 170 mm. The flange shall be provided with holes of $16^{+0,07}$ mm diameter for five fixing screws and a journal of $110_{-0,1}$ mm diameter for the centring of the brake drum and the drive wheel disc at a distance of 139,7 ± 0,08 mm.

The other half axis pivots have the following diameters: for the gasket sleeve of the driving half axis $d_1=42^{+0.058}_{+0.035}$ mm, for the ball bearing of the half axis $d_2=40^{+0.020}_{+0.03}$ mm and for the ring fixing the ball bearing $d_3=38^{+0.080}_{+0,50}$ mm.



3.27. Figure: DRIVE SHAFT WITH A REVOLVING MULTI-PASS OUTLINE
(POŁOŚ NAPĘDOWA O EWOLWENTOWYM ZARYSIE WIELOWYPUSTU)

■ The mounting ring for the drive shaft bearing (33, fig. 3.25), made of high-quality structural steel, is surface-hardened to a depth of 1.5...2 mm. The ring length is 28 mm and the outside diameter is $52_{-0.12}$ mm and the inside diameter is $38^{+0.027}$ mm.

■ The sealing sleeve of the drive shaft bearing (41, fig. 3.25), made of higher quality structural steel, is hardened to a depth of 1.2..2.2 mm. Its length is 24-014 mm, its outer diameter $52_{-0.12}$ mm and its inner diameter $42^{+0.039}$ mm.

■ The spring ring of the inner ring of the semi-axis bearing (32, Fig. 3.25) is made of structural steel with increased manganese content in the form of a truncated cone with a height of $2{,}8_{-0.4}$ mm. The outer diameter of the ring is 52 mm and the inner diameter $39^{+0,34}$ mm. The ring is hardened.

3.4.1 Drive axle type 18/23

■ The washer of the outer ring of the axle bearing (31, Fig. 3.25) is made of 0,25 mm thick steel sheet. The edge is pressed $1_{-0.3}$ mm high. The outer diameter of the washer is 89,5 mm and the inner diameter 78 mm.

Trouble	Reasons	Method of repair
1 Loud operation of the rear axle	1.1 Too little or no oil in the main gear unit housing.	1.1 Fill up with oil up to the level of the oil fill plug.
	1.2 Incorrect play between the teeth of the main gear unit.	1.2 Adjust the interdental clearance within the required limits. Refer the adjustment to the ASO or by a repair company.
	1.3 Crushed worn or damaged tines in the main gear unit.	1.3 Replace the main gearbox wheel pair, adjust the slack and preload, and the head gearbox toothed play.
	1.4. worn or damaged drive shaft or differential bearings.	1.4 Replace the bearings, adjust the clearances and preloads. Have the repair carried out by an ATS or by a repair company.
	1.5 Incorrect adjustment of the main gearbox bearing play	1.5 Perform the re-adjustment at the ATS or at the repair shop.
	1.6. Perpendicularity of the disc wheel face to disc axle (more than 0,08 mm).	1.6 Method of repair according to point 1.3.
	1.7 Released screw nuts fixing the disc pulley to the differential housing.	1.7 Tighten the bolts to the required torque.
	1.8 Incorrect interproximal clearance between the teeth of the differential bevel wheels.	1.8 Adjust the play by changing the stop washers. Have the ASO or a repair shop carry out the repair.
	1.9. crushed, worn or damaged teeth of the differential bevel gears.	1.9 Replace wheels with damaged teeth. Have the ASO or a repair shop carry out the repair.
	1.10. Satellite or crown washers, worn or seized.	1.10. Replace the washers. Have the ASO or a repair shop carry out the repair.
	1.11. Sealed crown kingpins in differential housing or on satellites with pins	1.11. Have the ASO or the repairer replace the clogged wheels, the differential casing or the satellite pin.
	1.12. Too tight a fit for the differential crown kingpins or for the lithium sate on the pin.	1.12. Grind the crown spindle or spindles. Have the ASO or a repair shop carry out the repair.
	1.13. Defective mounting or bent semi-plating (run over 1,0 mm).	1.13. Reassemble with possible replacement of the axle halves. Have the ASO or a repair shop carry out the repair.
	1.14. Deformed or cracked main transmission or differential housing	1.14. Replace damaged housings. Have the ASO or a repair shop carry out the repair.
	1.15. Half-fibre, bent or cracked.	1.15. Replace the complete semi-ridge. Have the ASO or a repair shop carry out the repair.
	1.16. Worn or damaged drive shaft bearing.	1.16. Replace the bearing and the retaining ring. Have the ASO or a repair shop carry out the repair.
2. Rear bridge over-heating	2.1 Reasons as in points 1.1, 1.2, 1.3, 1.5, 1.8, 1.9 or 1.12.	2.1. method of repair according to 1.1;1.2, 1.3;1.5, 1.9 or 1.12.
3. Tubes in the rear axle *Stuki w tylnym moście*	3.1 Worn splice connections on the drive shaft or drive semi-axis.	3.1 Replace the drive shaft (with disc pulley) or the drive shaft semi-spindle. Have the ASO or a repair shop carry out the repair.
	3.2 Reasons as in points 1.2, 1.3, 1.7, 1.9, 1.10, 1.13 or 1.15.	3.2. method of repair according to points 1.2, 1.3, 1.7, 1.9, 1.13 or 1.15.
	3.3 Breaked spring main pen (or full spring), malfunctioning shock absorbers or loosening of drive wheel fixing nuts.	3.3 Removal of identified defects by dimensioning and correct fixing of components.
4. Leakage of oil or grease	4.1 Excess oil in the main gear unit housing.	4.1 Drain the excess to the level of the inspection stopper (filling plug).
	4.2 Loss of breather blockage.	4.2 Clean, clear or replace the vent.
	4.3 Damaged seal on the drive shaft bearing cover.	4.3 Replace damaged gasket.
	4.4 Fixing screws on the main gear unit housing cover or the cover gasket defective.	4.4 Replace defective gasket and nuts with the required torque.

3.22. Table: REAR AXLE TROUBLESHOOTING

4. Leakage of oil or grease	4.5. worn or damaged transmission shaft seal.	4.5 Replace defective sealant.
	4.6. worn or damaged seals: rubber (oil spill) or felt (grease escaping) drive semi-axle.	4.6 Replace the seals. If the rubber gasket needs to be replaced, have the ASO or a repair company repair it.
	4.7. broken main or intermediate gear casing.	4.7 Replace damaged parts. Have the ASO or a repair shop carry out the repair.
	4.8. oil drain plug loose.	4.8 Tighten the drain plug.
5 Absence of wheel drive *Brak napędu na koła*	5.1. twisted semi-axle.	5.1 Replace the damaged axle housing. Have the ASO or a repair shop carry out the repair.
	5.2 Breaking out the tines of the main gearbox or differential.	5.2 Replace damaged wheels. Have the ASO or a repair shop carry out the repair.
6. Rear axle blocked	6.1 Foreign matter in main gear unit or differential.	6.1.-6.3 Have the repair carried out by an ATS or a repair company.
	6.2 Seizure of the drive shaft or differential bearings.	
	6.3 Damage to the differential (satellite pin protruding).	

■ The sealant for the drive shaft bearing (Fig. 3.24) consists of a steel plate (43) and a housing (42) screwed onto two M5 screws (39); a felt ring (37) with an outside diameter of $68^{+1.0}_{-0.8}$ mm, an inside diameter of $51^{+1.0}_{-0.8}$ mm and a thickness of 10 ± 1 mm is seated inside. A welded-on grease nipple (40) is attached to the housing (42) and works together with a lubricating grease nipple (40), which is attached to the inner flange of the semi-axis on the inside. This cover is radially pressed and, in the event of a leak, drains the grease (or oil) through the holes in the axle flange outside the brake drum.

Rear bridge operation includes:

- checking and refilling the oil in the main gear unit housing,
- to change oil,
- periodic grease replenishment (replacement) in the bearings of the drive axles,
- checking the connections for leaks and the airtightness of the vent.

Replenishing and changing the oil in the main gearbox housing is carried out in conjunction with refilling and changing the oil in the gearbox (the same procedure applies). The amount of gear oil in the housing is 1,1 dm^3.

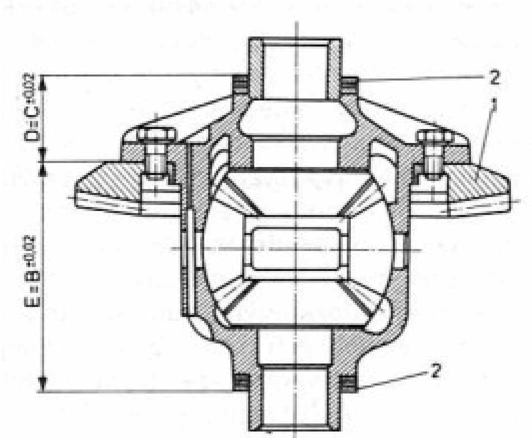
The grease replenishment of the axle bearings is carried out by screwing on the grease nipple covers (38, Fig. 3.25). The grease change in the bearings of the drive axles is carried out after the drive axles have been removed from the rear axle. Have this done by an ASO or a repair company. If there are leaks on the rear axle, first clean the vent and check for leghten the main gear unit housing screws and covers or replace damaged gaskets and seals.

The most common operating faults of the rear bridge, the reasons for them and information on how to remove them are presented in Table 3-22.

Repair of the rear bridge

The main gearbox housing and cover (with half-sleeves) are subject to replacement in the event of cracks or bends. As a rule, welding or hot straightening of components causes deformations and stresses that do not guarantee correct interaction between the main gearbox wheels, the half axles and the bearings. The collar end of the drive bout is clamped to a maximum depth of 0,5 mm by machining the drive bout with a radial runout tolerance of up to ?? mm.

Differential casing defective, cracked by uneven wear on the working surfaces of the exchange league. The housing is also eligible for replacement, gd: broken hole for satellite pin or when the spherical surfaces after the decaying resistance satellites are so worn that there is no possibility of erasing! The permissible radial runout of the inner surface of the sleeve, in relation to the tapered roller bearing pivots, is 0,04 mm. The retaining surface of the crown washers, which is seized or worn out unevenly, is polished or rolled and the material (up to 0,15 mm at ???) is filled with repair washers. During machining, the tapered roller bearing journal surfaces must be straight to the surface with a tolerance of 0,03 and parallel to the satellite shaft openings with a tolerance of 0,07 mm over a length of 100 mm.



3.28. Figure: SELECTION OF WASHERS FOR ADJUSTMENT OF BEARING CLEARANCE IN DIFFERENTIAL HOUSING

1 - complete differential.
2 – shims

1 - mechanizm różnicowy kompletny.
2 - podkładki regulacyjne

The drive shaft and disc wheel with tines showing material residues, signs of seizure or uneven wear qualify the main gear wheel horses for replacement.

Crown wheels and satellites with worn or damaged teeth are being replaced. The bearing surfaces of the crown wheels made of blockage-free sleeves are polished with thicker shims for the interdental clearance required and the clearance in the tapered roller bearings.

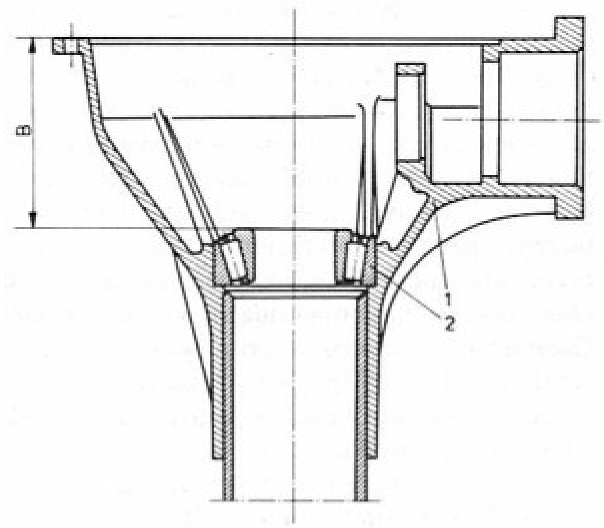
The satellite pin is regenerated by chromium plating and grinding of the pivots to the nominal size.

Half drive axles cracked, deformed, with worn out multi-crop: or enlarged screw holes for the running wheels at the base of the replacement. Chrome-plated and ground to nominal size, the journal of the seal sleeve can be subjected to a tolerance of up to 0,025 mm.

The mounting ring for the drive shaft bearing is replaced by a new one after the disassembly has taken place. It is unacceptable, due to the lack of safety (the possibility of the semi-axis sliding out during the journey), to use a ring or a ring alone which does not guarantee the required juice after pressing (the extrusion force should not be lower than that of the SC).

The sealing sleeve of the drive shaft is replaced with a new one if it is cracked or worn out unevenly. It is permissible to regenerate the external surface, cooperating with the felt sealant, by

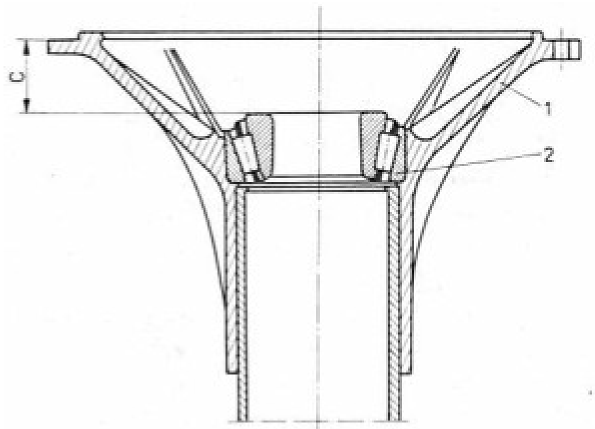
chromium plating and grinding to the nominal size, keeping the coaxiality within the limits of 0,025 mm (to be checked in the slides).



3.29. Figure: MEASURING THE FRONTAL DISTANCE OF THE MAIN GEAR UNIT HOUSING HOUSING FLANGE TO THE INNER RING FACE OF THE TAPERED ROLLER BEARING OF THE DIFFERENTIAL HOUSING

1 - main gearbox housing.
2 - tapered roller bearing of differential housing

1 - obudowa przekładni głównej.
2 - łożysko stożkowe obudowy mechanizmu różnicowego



3.30. Figure: MEASURING THE FRONTAL DISTANCE OF THE MAIN GEAR UNIT HOUSING HOUSING HOUSING FLANGE TO THE INNER RING FACE OF THE SHUTTLE MECHANISM HOUSING'S TAPERED INNER RING

1- the main gear unit housing cover.
2 - tapered roller bearing of differential housing

1- pokrywa obudowy przekładni głównej.
2 - łożysko stożkowe obudowy mechanizmu różnicowego

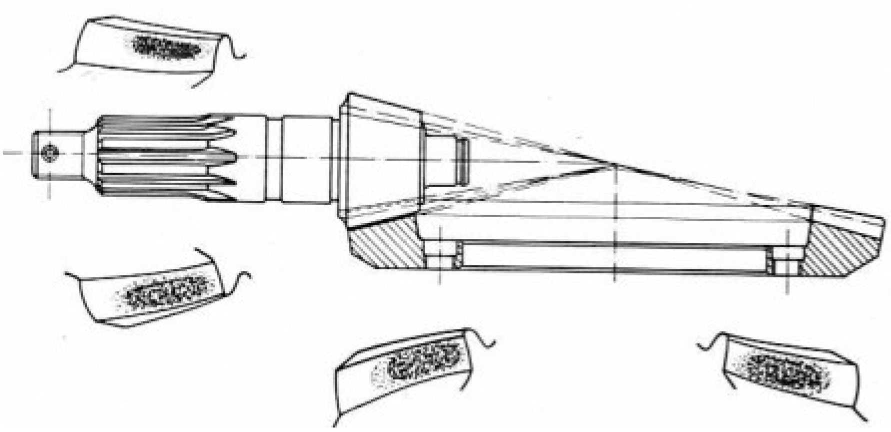
Other parts of the rear bridge that are worn or damaged will be replaced. When folding the rear bridge after repair, the correct reaction of bearing play and toothed play is essential behind the gem that determines its durability and smoothness.

The adjustment of the clearance in the twin-row drive shaft bearing p is carried out by washers (3, Fig. 3.25), selecting the thickness yes, when compressed with a spacer sleeve (4, Fig. 3.25) by force of 5...7 The pack height was 0.17...0.21 mm higher than the inner raceway faces of the twin-row bearing, which was tested under an axial load of 100...150 N. The blazing height of the

package was 0.17...0.21 mm higher. The bearing preload is called up by tightening the crown nut (11, fig. 3.25) at 117.6 N·m. The drive shaft (2, Fig. 3.25) built into the main gear unit housing shall rotate smoothly when loaded with a torque of 1,4...2,0 N-m in accordance with the above principles. The test is carried out without the disc wheel (1, Fig. 3.25) and the sealant (48, Fig. 3.25).

The adjustment of clearance in tapered roller bearings of the differential housing (14, Fig. 3.25) is based on the selection of adjustment washers (15, Fig. 3.25) so that the EiD dimensions (Fig. 3.28) do not differ from the dimensions B and C (Fig. 3.29, 3.30) by more than ± 0,02 mm. The resulting clearance in the bearing is obtained after the housing components have been screwed together (for the nut tightening torque see table 8-2) by means of a 0,12 mm thick gasket (23, fig. 3.25).

The adjustment of the interlocking clearance between the bevel wheels of the threaded mechanism is performed exclusively with washers (17, Fig. 3.25), the clearance between the housing's retaining surface and those of the properly adjusted differential mechanism should be within 0.1...0.3 mm, and the crown wheels should rotate with a torque of 5 N-m.



3.31. Figure: TRACES OF COOPERATION BETWEEN THE MAIN GEARBOX TINES (SLADY WSPÓŁPRACY ZĘBOW PRZEKŁADNI GŁÓWNEJ)

The adjustment of the pitch between the main gearbox wheels is made by aligning the drive shaft and the drive wheel in the housing so that it corresponds to the position of the lower and pre-set wheels of the manufacturer (see Chapter 3 Correct positioning of the drive shaft in the housing is achieved by applying pressure to the washers (12, Fig. 3.25) of such a thickness that the dimension L (Fig. 4) does not differ from the theoretical dimension L of 111,96 mm with a force of 0,02 mm. On the other hand, positioning of the disc wheel in the axial direction of the league only involves shifting the previously selected adjustment footbridges (15, Fig. 3.25) from one side to the other of both differentials (when adjusting the tapered roller bearings of the differential housing), with the washer of a thickness equal to the value of the pr to the left and vice versa (depending on the mounting hue mark M (Fig. 26) marked on the disc wheel) being used for positive displacement (the direction of the negative displacement is determined by the axis of the driving shaft). The clearance between the two must be between 0,1 mm and 0,3 mm after adjustment (measured at the end of the drive shaft on a radius of mm). The test is carried out with the disc wheel stationary after every four full turns of the drive shaft. The differences in display for the gearbox of one bridge

should not exceed 0.1 The marks of cooperation of the main gearbox wheel teeth should land, as in Fig. 3.31. If the picture is different (marks of side edges, etc.), the axial position corks of the drive shaft or disc wheel should be carried out in the manner described above (when hiding the required interlocking clearances).

The final check of the correctness of the adjustments made should be carried out twice at a special stand:

- without load and without oil at 1200...1500 rpm for the drive shaft; test period 30...60 s,
- with a torque drive shaft load of 20...30 N·m and oil heated to 50...60°C at a drive shaft speed of 2000...2500 rpm.

The rear bridge should operate with a constant noise, without any distinctive knocks, mud or rumble. The housing temperature, checked at the installation location of the double row transmission shaft bearing, shall not rise above 80 °C during the test and any leaks shall be rectified immediately. Further checks are already carried out when driving over the rear axle to the vehicle, bearing in mind that if the adjustment is not carried out correctly, the main gear teeth may not reach the correct position after approx. 1,500 km and that it may not be possible to achieve the correct adjustment parameters and that the drive wheels must not slip longer than 180 seconds until the first OT, as this may cause the differential to become severed.

3.4.2 Drive axle type 3005/3015

A mechanism consisting of a hypoidal main gearbox, a two-satellite differential and a drive half-axis is mounted in a single housing (22, Fig. 3.32) with pressed-on seams (28,41).

■ Hypoidal main transmission

The single-stage bevel gearbox with bevel gears with curved teeth, type GLEASON, is made up of a drive shaft (24, fig. 3.32) bearing on one side in two tapered roller bearings: inner (14), type 32308A and outer (16), type 33207A, and disc wheel (39) screwed to the differential housing (35) on 10 bolts M12x1,25, bearing jointly in the housing (22) on two tapered roller bearings (33), type 30210A, in which the outer ring was widened to 19,5 mm. The axis of the drive shaft is lowered by 31.75 mm from the disc wheel axis (so-called hypoidal displacement).

The gear wheels of the hypoidal gearbox, like the gear wheels of the type 18 gearbox, are lapped in pairs for silence and the size and arrangement of the tine interface.

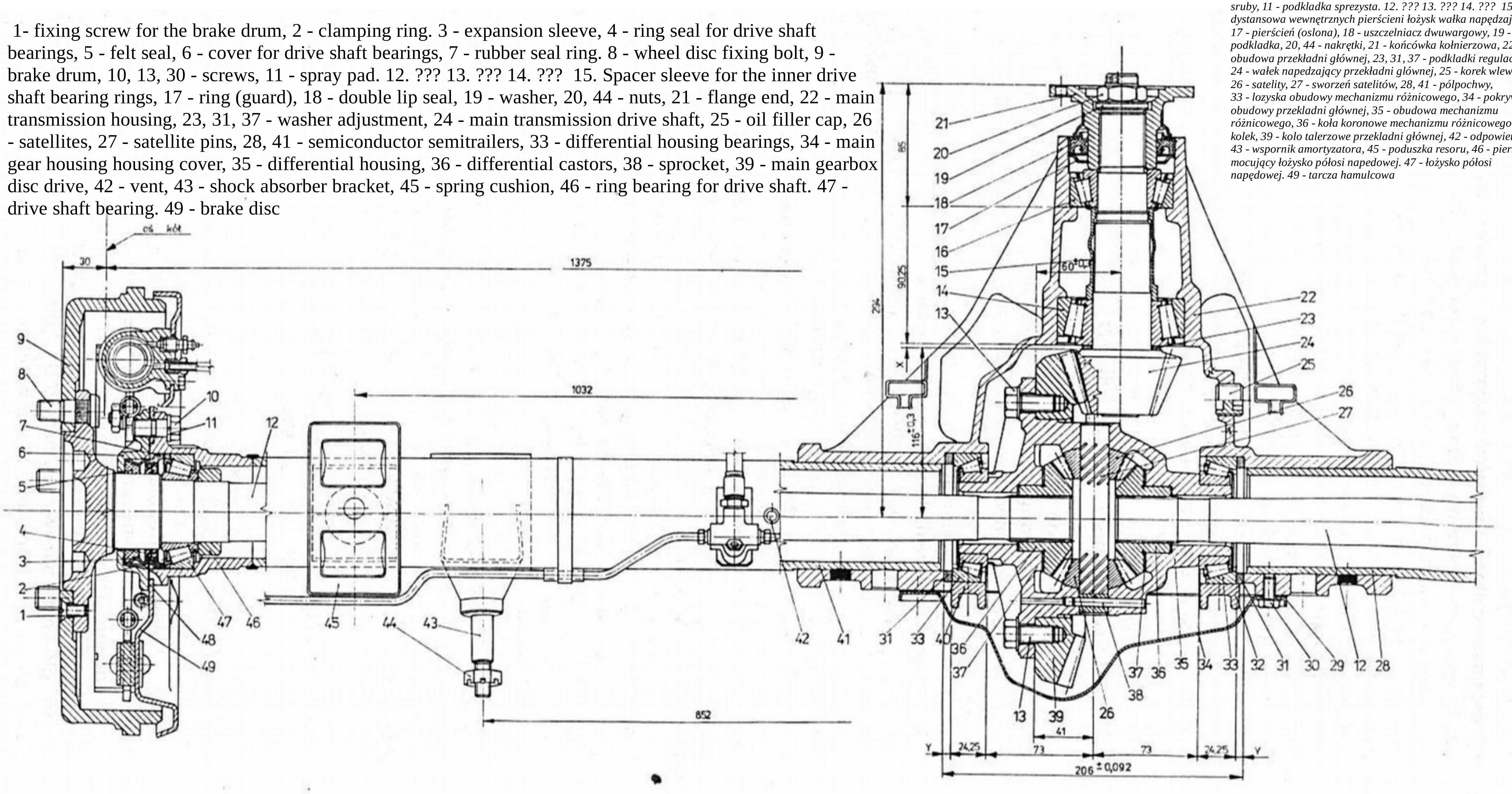
The sets are marked with a common serial number (Fig. 3.33), specifying the mounting deviation of the drive shaft from the disc wheel.

Adjustment of the axial position of the drive shaft is achieved by selection of shims (23, Fig. 3.32) of appropriate thickness (x). The preload of the drive shaft bearings is adjusted by tightening the nut (20, Fig. 3.32) to a torque of 176...255 N·m. The axial force induced is transferred to the inner rings of the tapered roller bearings (14, 16, fig. 3.32) by a washer (19, fig. 3.32), flange end (21, fig. 3.32) and spacer sleeve (15, fig. 3.32). The thickness of the shims (23, Fig. 3.32) is measured at an axial load of approximately 360 daN on the gear side of the drive shaft.

3.4.2 Drive axle type 3005/3015

1- wkret mocowania bębna hamulcowego, 2 - pierścien dociskowy. 3 - tuleja rozprężna, 4 - uszczelniacz pierścieniowy lożyska półosi napedowej, 5 - uszczelniacz filcowy, 6 - pokrywa łożyska półosi napedowej, 7 - gumowy pierścień uszczelniający. 8 - sruba mocowania tarczy koła jezdnego, 9 - beben hamulcowy, 10, 13, 30 - sruby, 11 - podkladka sprezysta. 12. ??? 13. ??? 14. ??? 15. tuleja dystansowa wewnętrznych pierścieni łożysk wałka napędzającego, 17 - pierścień (oslona), 18 - uszczelniacz dwuwargowy, 19 - podkladka, 20, 44 - nakrętki, 21 - końcówka kołnierzowa, 22 - obudowa przekładni głównej, 23, 31, 37 - podkladki regulacyjne, 24 - wałek napedzający przekładni glównej, 25 - korek wlewu oleju, 26 - satelity, 27 - sworzeń satelitów, 28, 41 - pólpochwy, 33 - lozyska obudowy mechanizmu różnicowego, 34 - pokrywa obudowy przekladni głównej, 35 - obudowa mechanizmu różnicowego, 36 - koła koronowe mechanizmu różnicowego, 38 - kolek, 39 - kolo talerzowe przekladni głównej, 42 - odpowietrznik, 43 - wspornik amortyzatora, 45 - poduszka resoru, 46 - pierscien mocujący łożysko półosi napedowej. 47 - łożysko półosi napędowej. 49 - tarcza hamulcowa

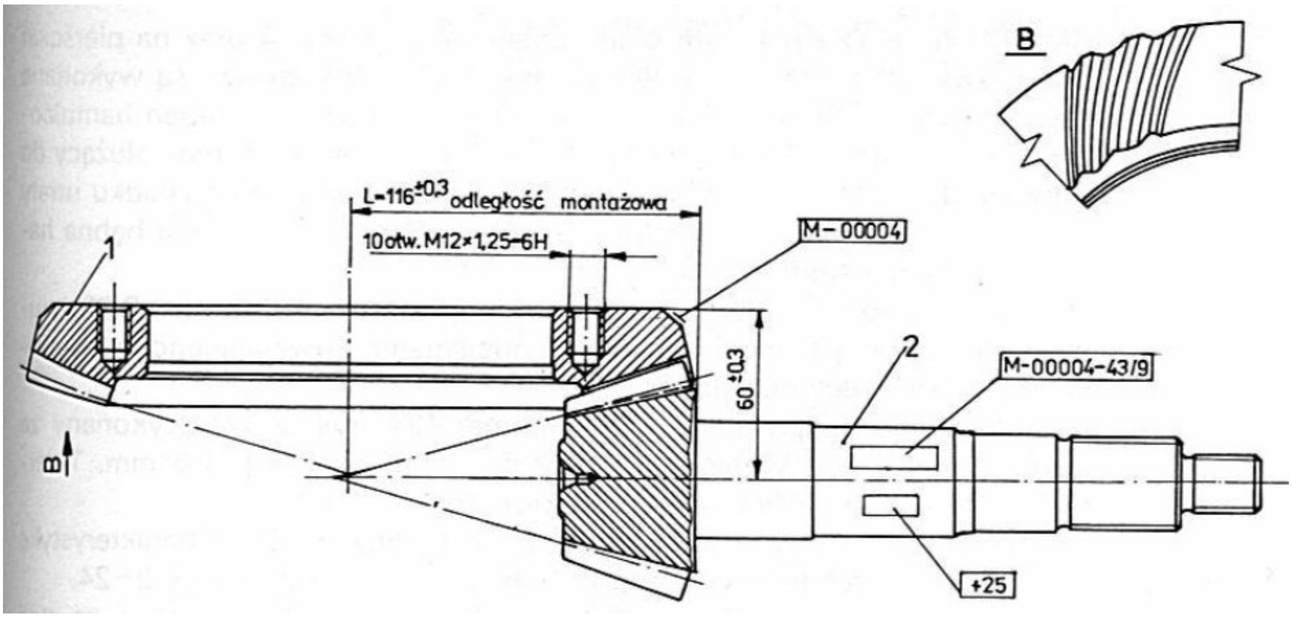
1- fixing screw for the brake drum, 2 - clamping ring. 3 - expansion sleeve, 4 - ring seal for drive shaft bearings, 5 - felt seal, 6 - cover for drive shaft bearings, 7 - rubber seal ring. 8 - wheel disc fixing bolt, 9 - brake drum, 10, 13, 30 - screws, 11 - spray pad. 12. ??? 13. ??? 14. ??? 15. Spacer sleeve for the inner drive shaft bearing rings, 17 - ring (guard), 18 - double lip seal, 19 - washer, 20, 44 - nuts, 21 - flange end, 22 - main transmission housing, 23, 31, 37 - washer adjustment, 24 - main transmission drive shaft, 25 - oil filler cap, 26 - satellites, 27 - satellite pins, 28, 41 - semiconductor semitrailers, 33 - differential housing bearings, 34 - main gear housing housing cover, 35 - differential housing, 36 - differential castors, 38 - sprocket, 39 - main gearbox disc drive, 42 - vent, 43 - shock absorber bracket, 45 - spring cushion, 46 - ring bearing for drive shaft. 47 - drive shaft bearing. 49 - brake disc



3.32. Figure: HYPOIDAL REAR AXLE

3.4.2 Drive axle type 3005/3015

Adjustment of the axial position of the disc wheel is achieved by selection of washers (31, Fig. 3.32) of appropriate thickness (y). To induce the bearing voltage (33, Fig. 3.32), the elasticity of the main gearbox housing is used. The adjustment of the disc wheel position and voltage of the above mentioned bearings is carried out with the same set of washers (31, Fig. 3.32). The thickness shall be selected with axial loading by means of a force of approximately 400 daN. The bearing voltage is checked by measuring the deformation of the main gear unit housing (base dimension 206 ± 092 mm). The correct value of deformation shall be within 0,11...0,15 mm.



3.33. Figure: MARKING OF THE HYPOIDAL GEARBOX WHEEL PAIR

1 - disc wheel, 2 - drive shaft, M - year code according to PN-81/S-02051, 00004 - serial number of the main gearbox gear pair. +25 - sign and size of the deviation of the mounting dimension L. 43/9 - quotient of the number of teeth of the disc wheel and the drive shaft

1 - koło talerzowe, 2 - wałek napedzający, M - kod roku produkcji wg PN-81/S-02051, 00004 - kolejny numer produkcyjny pary kół zębatych przekladni głównej. +25 - znak i wielkość odchylki wymiaru montażowego L. 43/9 - iloraz liczby zębów kola talerzowego i wałka napędzającego

The torque required to turn the correctly assembled drive shaft (without differential and disc wheel) shall be within 1,8...2,8 N·m. The clearance between the teeth of the main transmission (with the drive shaft stationary) shall be within 0,08...0,22 mm, provided that the difference for one transmission at different wheel positions shall not exceed 0,08 mm.

■ The main gearbox housing (22, Fig. 3.32) is made of spheroidal graphite cast iron reinforced with ribs. The diameters of the sockets in the housing are as follows:

- for the external bearing of the drive shaft $72^{-0.014}_{-0.033}$ mm,
- on the inner bearing of the drive shaft $90^{-0.016}_{-0.038}$ mm,
- for the flange end gasket $75^{+0.046}$ mm,
- on half-track $75^{+0,046}$ mm,
- with differential bearing mechanism $90^{+0.04}_{-0.018}$ mm,

3.4.2 Drive axle type 3005/3015

The differential bearing seats are divided. The spheroidal graphite cast iron (ductile iron) covers are machined together when screwed to the housing with two M12 screws each. For the sake of interchangeability during repairs and installation, they are marked with the numbers 1-1 and 2-2 on the cover and on the housing.

Definition	Dimensions, mm
Pivot diameter of inner bearings	$40^{+0,025}_{+0,05}$
Pivot diameter of outer bearings	$35_{-0,016}$
Multi-volume shaft:	
- number of teeth	30
- modulus	1,0
- angle of inclination	30°
Threaded end	M20x1,5
Total length of the roller	231

3.23. Table: ESSENTIAL DIMENSIONS OF THE DRIVE SHAFT OF THE HYPOIDAL MAIN GEAR UNIT

Definition	Size
Number of teeth	9
Angle of support of the concave tooth side	20°28’
Angle of buttress of the convex tooth side	24°32’
Mean angle of tooth line inclination	50°09’
Direction of tooth line inclination	left
Hypoidal shift	31,75 mm
Average tooth thickness in the normal plane	7,95 mm

3.24. Table: CHARACTERISTICS OF THE GEARWHEEL OF THE DRIVE SHAFT OF THE HYPOIDAL MAIN GEARBOX

Definition	Size
Number of teeth	43
Front module	5,349 mm
Angle of support of the concave tooth side	20°28’
Angle of buttress of the convex tooth side	24°32’
Mean angle of tooth line inclination	32°01’
Direction of tooth line inclination	right
Hypoidal shift	31,75 mm
Total height of tooth	10,50 mm

3.25. Table: TOOTH CHARACTERISTIC OF THE DISC WHEEL OF A HYPOIDAL MAIN GEARBOX

The casing is closed with a cover (34, fig. 3.32) of 1.5 mm thick steel sheet, fastened to 10 M8 screws (30, fig. 3.32) by means of a gasket (29, fig. 3.32) made of 1.6 mm thick Betaflex. To top up or drain the gear unit oil from the housing, two holes are provided in the housing with plugs with M22x1.5 threads, the filling plug (25, fig. 3.32) also acts as an oil level plug in the housing. The drain plug has a magnetic insert to capture the swarf caused by the wear and tear of the gear unit. To lubricate the external drive shaft bearing, an oil channel is provided in the casting of the main gear unit housing. The amount of oil to be filled in the housing is 1.9 dm^3.

■ The half-clips (28, 41, Fig. 3.32) are made of a steel tube with an outside diameter of 76,1 mm and a wall thickness of 4,5 mm. On one side, they have $75^{+0,105}_{-0,075}$mm diameter pivots to be pressed into the housing (they are protected against pulling out three hole joints each). On the other hand, the semi-rings are finished with flanges welded to the pipes. They have seats with a diameter of $80^{+0,040}_{+0.010}$ mm for TIMKEN U-499-4460L tapered roller bearings (47, fig. 3.32) or SKF 331761 B replacement bearings (with a split outer ring) and a pressure ring (2) with a seal (4, fig. 3.32). The flange has four holes with a diameter of $10,2^{+0.2}$ mm for screws fixing the brake drum and the running wheel, as well as a channel with a width of 5 mm for removing oil to the outside of the backing plate, in case of the effectiveness of the semi-axle sealers. The journal for fixing the mulch drum is $95_{-0.070}$ mm in diameter.

A chewing air vent (42, Fig. 3.32) is fitted on the left half vamp during operation to compensate for the excess pressure generated in the outer ring.

■ The drive shaft of the main gearbox (24, fig. 3.32) made of alloyed steel is carbon nitrated to a depth of 0,8...1,0 mm. The basic dimensions of the shaft are given in Table 3-23. The characteristics of the gear cut on the shaft are given in Table 3-24.

■ The alloyed main gear disc (39, Fig. 3.32) is carbon nitrated to a depth of 0,8...1,0 mm. The hardness of the heat-treated teeth is 58...61 HRC.

The disc wheel with external diameter 230 mm has an internal diameter of $140^{+0.040}$ mm and is designed to be mounted on the journal of the differential using 10 M12x1.25 screws evenly spaced over 162 mm. The characteristics of the disc cut are given in table 3-25, the width of the rack ring is 35 mm.

■ The spacer sleeve (15, fig. 3.32) for the inner bearing rings of the drive roller is made of a steel pipe with an outside diameter of 48.3 mm and a wall thickness of 1.5 mm and is 58.5 mm long.

■ The shims (23, Fig. 3.32) made of high-manganese steel have an outer diameter of 54 mm and an inner diameter of $40^{+0.240}_{-0.080}$ mm. They are produced in 15 thickness dimensions from 2,40 to 3,10 mm and selected every 0,05 mm.

■ The ring (17, Fig. 3.32) made of 1,5 mm thick steel sheet has an outer diameter of $75^{-0,1}_{-0.2}$ mm and an inner diameter of 50 mm. It provides an additional seal to seal the mounting space of the drive shaft bearings.

■ The flange end of the drive shaft (21, Fig. 3.32), forged from higher quality structural steel, is 57 mm long.

The tip has an internal grooved spline with the characteristics given in Table 3-23, which is cut, surface hardened and polished, and has an external diameter of $48_{-0.05}$ mm. The pivot for use with the sealant has a diameter of 2,5 mm and a diameter of 2,5 mm. The flange has four holes with a diameter of $10^{+0,08}_{+0.17}$ mm for fixing the drive shaft.

Differential mechanism

The differential structure of the hypoidal bridge is similar to that of the bridge 18 (23).

■ The differential housing (35, Fig. 3.32) is a thick-walled ductile iron casting. The flange, 195 mm in diameter and 12 mm thick, reinforced with 10 ribs, has holes of $12{,}3^{+0.2}$ mm in diameter for the screws (M12x1.25) for the disc wheel. The diameter of the pivot for the disc pulley fixing is $140^{+0.014}_{-0.011}$ mm. Windows are left in the side walls of the casing through which it is possible to install the differential cone wheels. The sockets in the housing have the following diameters: for the crown pivots $46^{+0.039}$ mm, for the satellite pin $21^{+0.012}_{-0.008}$ mm, and for the pin protecting the satellite pin $6^{+0.03}$ mm. The distance between the thrust surfaces of the crown washers is $72^{+0.2}$ mm.

The sockets in the satellite housing are segments of a sphere with a diameter of $100^{+0.212}_{+0.072}$ mm (with the centre located at the intersection of the axis of the pin of the satellites with the axis of the propelling semi-axis).

The differential housing, assembled with the disc wheel, is housed in the main gearbox housing. The bearing journal diameters are $50^{+0{,}034}_{-0{,}09}$ mm and the bearing ring inner thrust planes are 146 ± 0,06 mm apart (33, Figure 3.32).

Number of teeth	16
Module	5,2285 mm
Angle of support	22°30’
Total height of tooth	10,72 mm
Angle of top of index cone	58°

3.26. Table: TOOTH CHARACTERISTICS OF THE CROWN WHEELS OF THE DIFFERENTIAL MECHANISM

Number of teeth	10
Module	5,2285 mm
Angle of support	22°30’
Total height of tooth	10,72 mm
Angle of top of index cone	32°

3.27. Table: TOOTH CHARACTERISTICS OF THE SATELLITES OF THE DIFFERENTIAL MECHANISM

■ Crown wheels (36, fig. 3.32) made of alloyed steel are carbon nitrated to a depth of 0.08...1.0 mm and hardened. Their outer diameter is $85_{-0.2}$ mm. The multi-glaove has the same dimensions as the crown wheels of the bridge differential 18 (23). The journal diameter for the crown wheel bearing in the differential housing is $46^{-0.050}_{-0.075}$ mm.

The gear characteristics of the crown wheels are given in table 3-26. In a correctly assembled differential, the crown wheels should rotate without jams after applying a torque of 35...59 N·m.

■ The satellites of the differential mechanism (26, Fig. 3.32) are made of the same material as the crown wheels. The outer diameter of the satellite is $60_{-0.2}$ mm and the diameter of the pin hole is $21^{+0.040}_{+0.061}$ mm. The dentition characteristics of the satellites are given in Table 3-27.

The sliding surface of the satellite, which cooperates with the socket made in the differential housing, is in the shape of a spherical bowl (radius of the sphere $50_{-0.025}$ mm). Total height of the satellite: $23_{-0.2}$ mm.

■ Satellite pin (27, fig. 3.32) made of alloyed steel, is carbonase poured in to a depth of 0,8...1,0 mm, hardened and phosphated. The average outside diameter of the pin is $21_{-0.013}$ mm and its length

is $135_{-0.3}$ mm. S Routine lubricating grooves at the satellite bearing location and the diameter of the safety pin hole 6x6x50 are as large as for bridge 18 pin.

■ The crown washers (37, Fig. 3.32) made of tin plated bronze have an external diameter of 72 mm and an internal diameter of $46{,}5^{+0.2}$ mm. They are manufactured in four thickness dimensions: 1,45, 1,50, 1,55 1,60 mm with a deviation of ± 0.025 mm, allowing correct adjustment of the interdental diameter (0.10...0.15 mm). In the plane adjacent to the crown, the washers are cut with lubricating grooves of a depth of ?? mm.

■ The differential bearing supports (31, fig. 3) made of higher quality structural steel are manufactured in 15 thicknesses (from 5,40 mm to 6,10 mm with a 0,05 mm gradation). They have an outside diameter of $90^{-0.12}_{-0.26}$ mm and an inside diameter of 76 mm.

Drive shafts

The hemispheres (12, Fig. 3.32) are mounted on the main gearbox side in the differential cams and on the wheel side in tapered roller bearings (47, Fig. 3.32) of special design. The clamping rings (46, fig. 3.32) prevent the tapered roller bearing outer rings (47, fig. 3.32), which are tensioned with a tapered bushing (3, fig. 3.32), from sliding out of the half-cheve by means of a clamping ring (2, fig. 3.32). The expansion sleeve (3) eliminates the axial clearance that occurs as the bearing wears out (47).

The semi-axis bearings are lubricated with the same gear oil as the main gearbox wheel pair and differential. On the contact wheel side, the axle bearings are sealed with a rubber gasket (4, Fig. 3.32), a felt gasket (5, Fig. 3.3) and a gasket made of cast iron (4, Fig. 3.32) placed under the bearing cover (6, Fig. 3.32).

■ The drive shaft, forged from higher quality structural steel, is surface-hardened to a depth of 3...5.5 mm. On the one hand, it ends with a splined spline of the characteristics given in Table 3-20, on the other hand with a flange of dimensions, as for the half axis of the bridge 18 (23).

The hemispherical pivots have diameters:

- for bearing sealers $52_{-0.074}$ mm,
- for tapered roller bearing $45^{+0.042}_{+0.025}$ mm,
- per clamping ring of the aforementioned bearing $42^{+0.161}_{+0.0136}$ mm.

■ The mounting ring for the drive shaft bearing (46, fig. 3.32) is made of higher quality structural steel. It has a length of 15 mm, an outside diameter of 60 mm and an inside diameter of $42^{+0{,}025}$ mm. The ring is pressed in cold.

■ The pressure ring (2, Fig. 3.32) made of steel tube has an outer diameter of $80^{+0.018}_{-0.012}$ mm and an inner diameter for the seat of the sealing ring $68^{+0.046}$ mm. A $3{,}2^{+0.2}$ mm wide groove is made on the outer surface of the ring to accommodate the rubber sealing ring (7, fig. 3.22).

■ An expansion sleeve (3, Figure 3.32) made of 1,2 ± 0,1 mm thick steel sheet shall have a diameter of 70,6 ± 0,1 mm and a free length of 17 ± 0,1 mm. Over the entire deflection range from 0 mm to 1.0 mm, it provides the outer bearing ring pressure of the semi-axis bearing with a force of 1700...2500 daN.

■ The cover of the semi-axis bearing (6, fig. 3.32), forged from higher quality structural steel, is attached to the semi-axis flange with four M10x1.25 screws. The central bore is 54 mm in diameter and an expansion sleeve seat is 74 mm in diameter. In the lower part of the cover there is a channel which drains the gearbox oil out of the brake disk in case of loss of tightness of the semi-axle sealants.

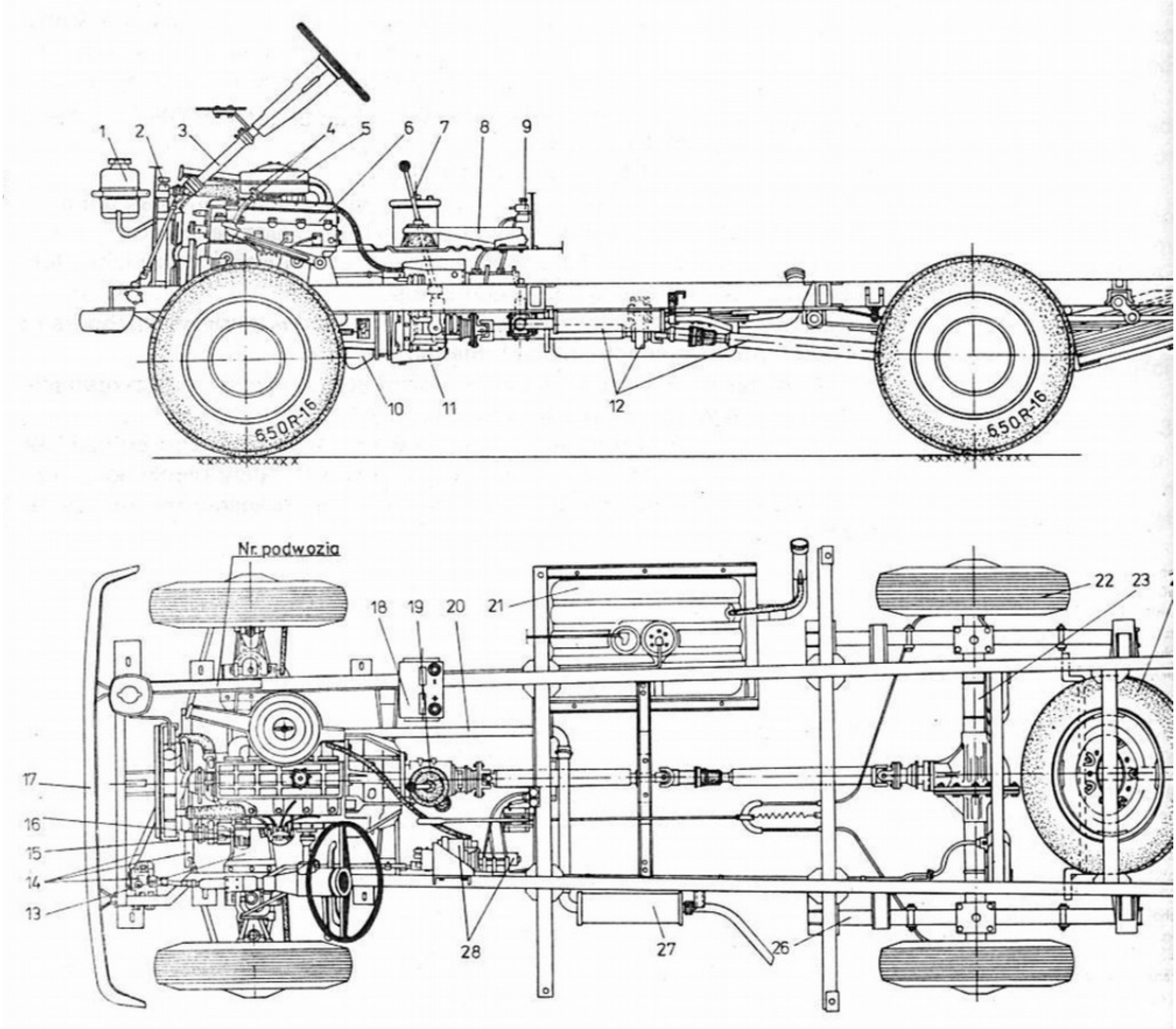
Maintenance and repair of rear axle 3005 (3015)

Maintenance and repair of the rear hypoidal bridge are the same as for the axle type 18 (23). The differences (resulting from the construction) boil down to:

- the absence, during maintenance, of replenishment or replacement of the grease in the semi-axle bearings,
- the possibility of using repair washers for satellites, which are not available in the new bridges,
- other rules for adjusting bearing play and toothed play (see description at the beginning of this chapter),
- quiet running tests at 900...3500 rpm for the drive shaft and at oil temperature (85°C) for the drive shaft speed of 3000 rpm for the ambient temperature of 20 ± 5°C.

4FRAME AND SUSPENSION SYSTEMS

Żuk use a typical chassis (Fig. 4.1), which consists of the frame (25), wheels including front and rear suspension and steering and braking systems. The frame is equipped with drive units, i.e. engine (6) with clutch and gearbox, drive shaft (12) and rear axle (23). These chassis assemblies also include components and systems permanently connected to the frame, such as the fuel supply system from the tank, the water cooler, the engine exhaust system including the silencer, accessories, etc., and shall be constructed and repaired in such a way that they can be easily integrated into the chassis assembly. On each chassis (frame) there is a car identification number stamped. This number is also stamped on the car's name plate.



4.1. Figure: CHASSIS

1 - cooling system equalisation tank, 2 - water cooler. 3 - steering column, 4 - clutch and brake pedals, 5 - air filter, 6 - engine S-21,7 - shift lever, 8 - parking brake lever, 9 - brake fluid reservoirs, 10 - clutches. 11 - gearbox, 12 - drive shaft, 13 - front suspension, 14 - steering mechanism. 15 - oil filter, 16 - alternator, 17 - front bumper. 18 for battery, 19 for gear shift, 20 for exhaust, 21 for fuel tank, 22 for chassis wheel, 23 for rear axle. 24 - spare wheel, . 25 - frame, 26 - springs, 27 - silencer, 28 - brake and servo pump

1 - zbiornik wyrównawczy układu chlodzenia, 2 - chłodnica wody. 3- kolumna kierownicy, 4 - pedały sprzęgła i hamulca, 5 - filtr powietrza, 6- silnik S-21,7 - dźwignia zmiany biegów, 8 - dźwignia hamulca postojowego, 9 - zbiorniczki płynu hamulcowego, 10 - sprzęgło. 11 - skrzynka biegów, 12 - wał napędowy, 13 - przednie zawieszenie, 14 - mechanizm kierowniczy. 15 - filtr oleju, 16 - alternator, 17 – zderzak przedni. 18 - akumulator, 19 - mechanizm zmiany biegów, 20 - przewody wydechowe, 21 - zbiornik paliwa, 22 - koło jezdne, 23 - tylny most. 24 - koło zapasowe, . 25 - rama, 26 - resory, 27 - tłumik, 28 - pompa hamulcowa i serwo

4.1 CHASSIS

4.1 CHASSIS

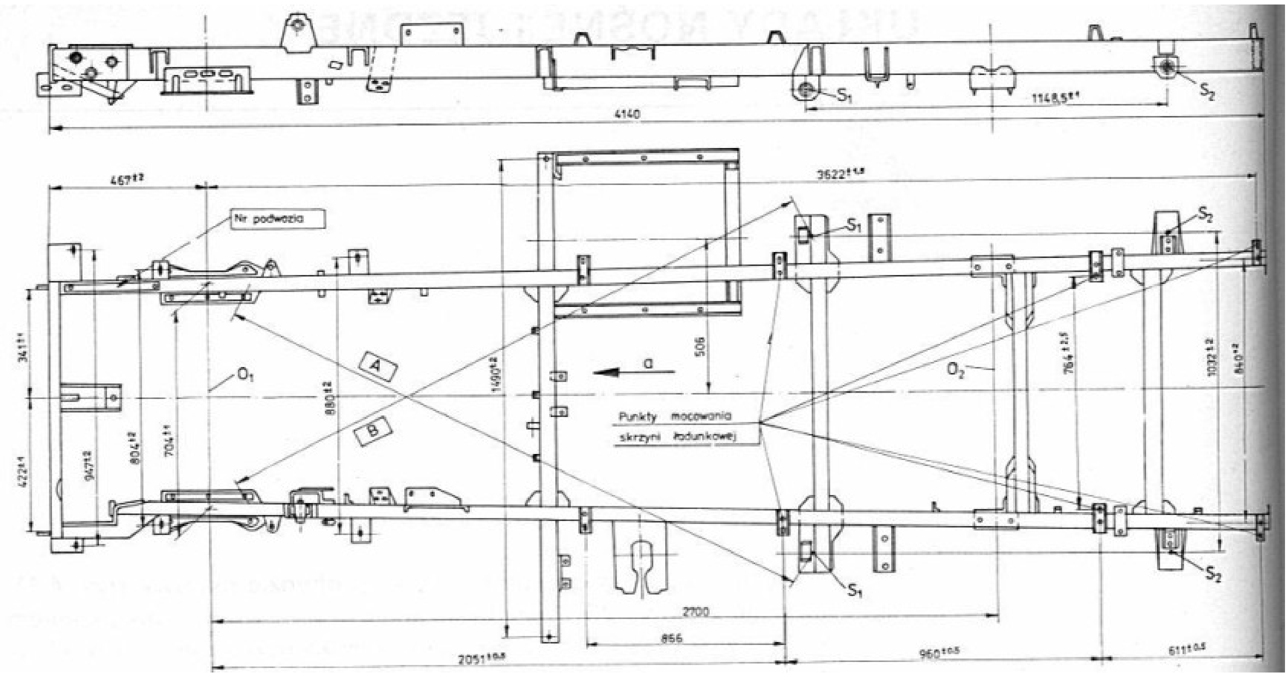
The longitudinal, flat frame is made of two stringers and three rectangular cross-bars 50x100 mm thick of steel sheet, 3 mm thick (Fig. 4.2). The frame weighs 130 kg.

■ The frame fulfils the function of a beam providing the required strength and stiffness. It works in very difficult conditions, because it is loaded with vertical forces, bending and torsional moments. It is also subject to all static and dynamic external loads that affect the chassis when the vehicle is in motion. To reduce the load on the frame crossbars, the drive units and chassis are attached to the side-members and their welded-on brackets, and a bolted-on beam is used for attaching the clutch motor and gearbox and for attaching the front suspension to the frame.

The bars are electrically welded to the frame stringers by fillet welds. At the corners of the crossbars to the stringers, reinforcing plates are welded in. The two central bars have welded brackets for securing the cab and the load platform.

Front and rear suspension brackets, cab, bodywork, front bumpers, radiator, clutch and brake pedals are also welded to the frame. On the right side of the frame there is a welded steel frame for fixing the fuel tank.

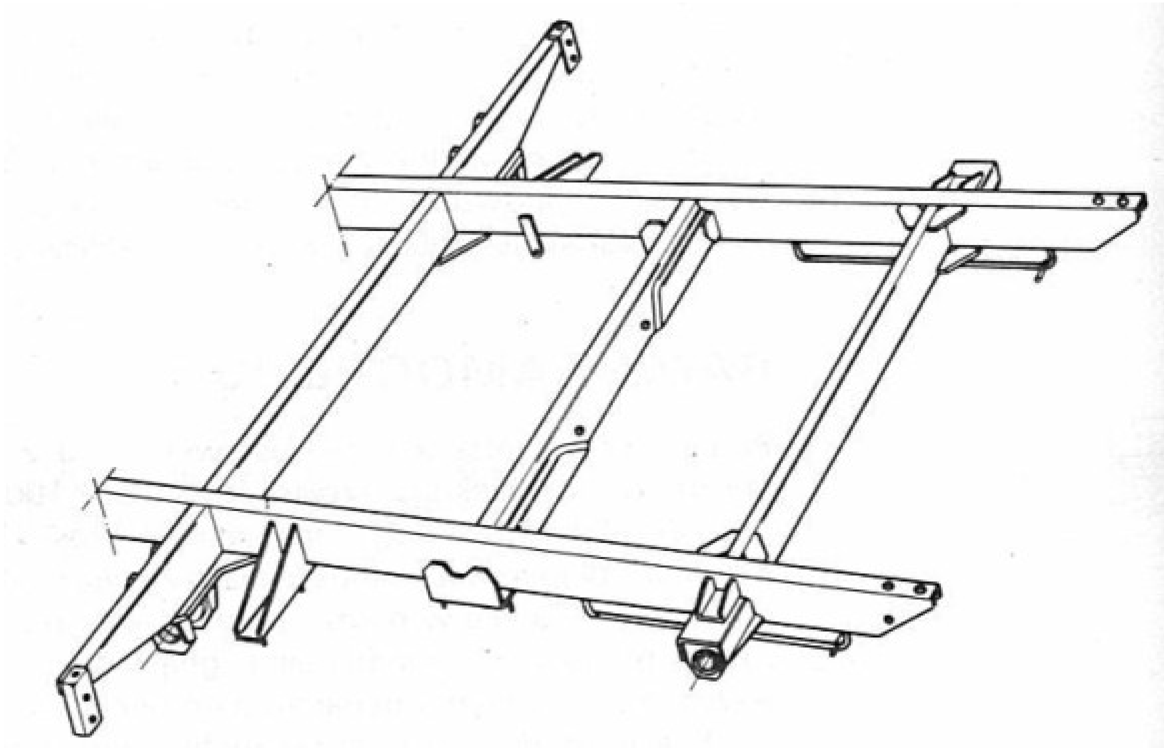
In front of the rear crossbar there is an additional channel crossbar welded to the stringers, made of 2 mm thick steel sheet used for fixing rear shock absorbers.



4.2. Figure: A111 VEHICLE FRAME

a - direction of travel
0_1 - front wheel axle
0_2 - axle of rear wheels,
S_1,S_2 - axles of spring mounting brackets

a - kierunek jazdy
0_1- oś kół przednich
0_2 - oś kół tylnych,
S_1, S_2 - osie wsporników mocowania resorów



4.3. Figure: REAR PART OF THE A06 VEHICLE FRAME

Behind the front axle is a 3 mm thick steel plate with six screws for the rear engine mounting crossbar to the stringers. This 666 mm long and 138 mm high bar has two Ø 28 mm holes in the centre and three 0 9 mm holes for mounting the motor. The frame of the car Żuk A06 is shown in figure 4.3, while the frame of the car A17 in figure 4.4. The frames of other car variants differ by additional brackets. A steel plate (at the front on the right-hand side) is welded to each car-mounted frame, on which the car identification number is stamped, e.g. SUL 175 11 BL 0530835. The same number is also stamped on the nameplate (see Fig. 1.11).

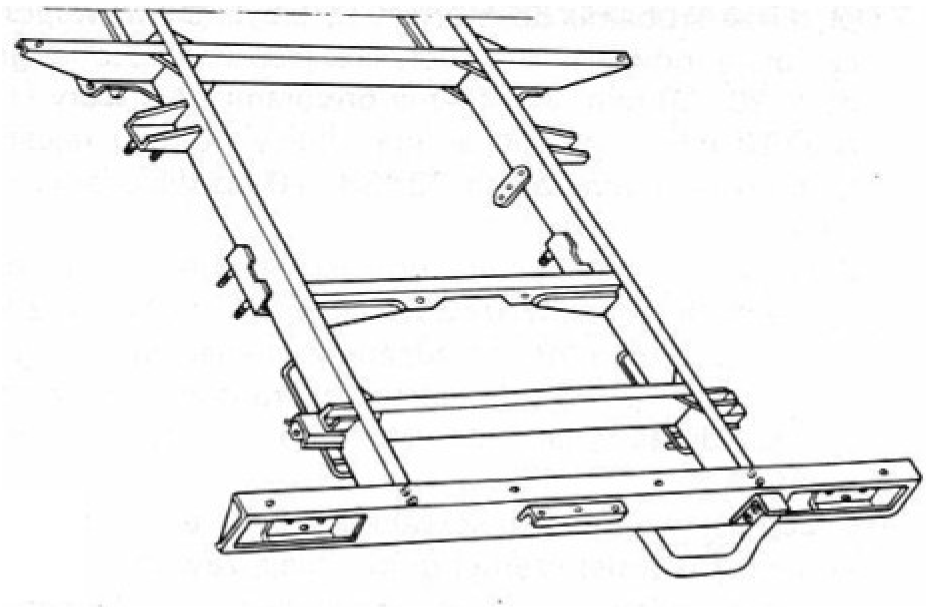
Subsequent units of the identification number indicate:

- S - Europe,
- U - Poland,
- L – Lublin,
- 175 - car variant A175,
- 1 - S-21 motor,
- 1 - basic engine variant,
- B - type of transmission,
- L - year of manufacture 1990,
- 0530835 - chassis serial number.

The number of frames for spare parts includes the C.Z. mark and the month and year of manufacture, e.g. 00001-C.Z. 06-90.

4.1 CHASSIS

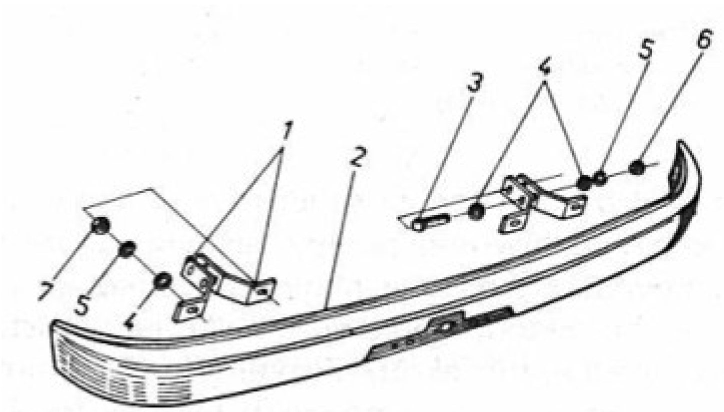
After replacing the frame in the car, e.g. during a general overhaul, the number of the new frame (chassis) shall be entered in the proof of the traction unit of the car.



4.4. Figure: REAR PART OF FRAME OF ISOTHERMAL AND CONTAINER VEHICLES

A frame in proper working order shall meet the following requirements:

- the points of attachment of the cab shall be in the same plane as the upper surface of the side members; the maximum deviation from the flatness of this surface shall not exceed ± 2 mm;
- the permissible deviation of the longitudinal and crossbar axes from straightness shall not exceed ± 3 mm;
- the difference in control dimensions A-B shall not exceed 3 mm;
- the axis of the front wheels and the axles of the spring supports shall be perpendicular to the longitudinal axis of the frame; the permissible deviation for the axles of the front wheels may be up to 2 mm and for the axles of the spring supports up to 3 mm.



1 - support, 2 - bumper, 3 - bolt M10x35, 4 - support, 5 - spring support, 6, 7 - nuts

1 - wspornik, 2 - zderzak, 3 - śruba M10x35, 4 - podkladka, 5 - podkladka sprężysta, 6, 7 - nakrętki

4.5. Figure: FRONT BUMPER (ZDERZAK PRZEDNI)

The frame is painted by immersing in a set of modern painting and water-borne products: hydromat II 622-393-860 primer and hydrophthalic enamel 6262-397-990.

■ The front bumper (Fig. 4.5), used in all types of ŻUK car, is pressed from 2 mm thick steel sheet. It has a channel profile with dimensions of 129.7 x 52 mm. The bumper is 1,672 mm long and 250 mm wide. Four screw plates are welded from inside the bumper to which the bumper supports (1) are attached. A 560x90x50 mm four-hole socket (2 holes Ø 7,5 mm and 2 holes Ø 10 mm) for mounting the registration number plate and a 22x38x10 shape otv for inserting the engine starter crank are embossed on the front surface of the bumper.

The bumper is screwed to the supports on the front crossbar of the frame with four M10x35 bolts; due to the fact that the bumpers are exposed to contamination, e.g. imposed from the road surface, they are carefully protected against corrosion by priming them with a synthetic primer and repainted twice with synthetic enamel in the colour of the body.

■ Rear bumpers are used only in vans. They are made of hard black rubber and have vulcanised steel inserts with two M8 screws for fixing in the left and right corner (see Fig. 7.40).

The frame as a supporting unit can be damaged during operation in the form of cracks, deformations, corrosion or creases. During maintenance, the condition of the frame must be carefully checked and remedied immediately if damage is detected. The dimensions of the frame shall be checked against the criteria given in Table 4-1.

Measured quantity	**Dimensions, mm**		**Recommended repair**
	nominal	**perimeter**	
Diagonals A and B, as illustrated in Figure 4.2	A=B	difference between A and B dimensions - max. 3 mm.	If the dimensional difference between A and B is greater than 3 mm, the frame must be replaced by a new one.
Diameter of holes in the spring front bracket - in the outer wall - in the inner wall	 $45^{+0,039}$ $14^{+0,027}$	 45,1 14,1	If the diameters of the holes are larger than the limit dimensions, the bracket must be replaced.
Diameter of the hole in the rear eye of the spring support	$35^{+0,250}$	35,5	If the diameter of the hole is greater than 35.5 mm, the bracket must be replaced.
Diameter of the hole in the inner bushing of the brake and clutch pedal shaft bracket (measured at a distance of 10 mm from the front surface)	$22^{+0,90}_{+0,50}$	22,35	If the diameter of the sleeve is greater than 22.35 mm, the inner sleeve must be replaced by the following.

4.1. Table: CONTROL DIMENSIONS OF THE FRAME

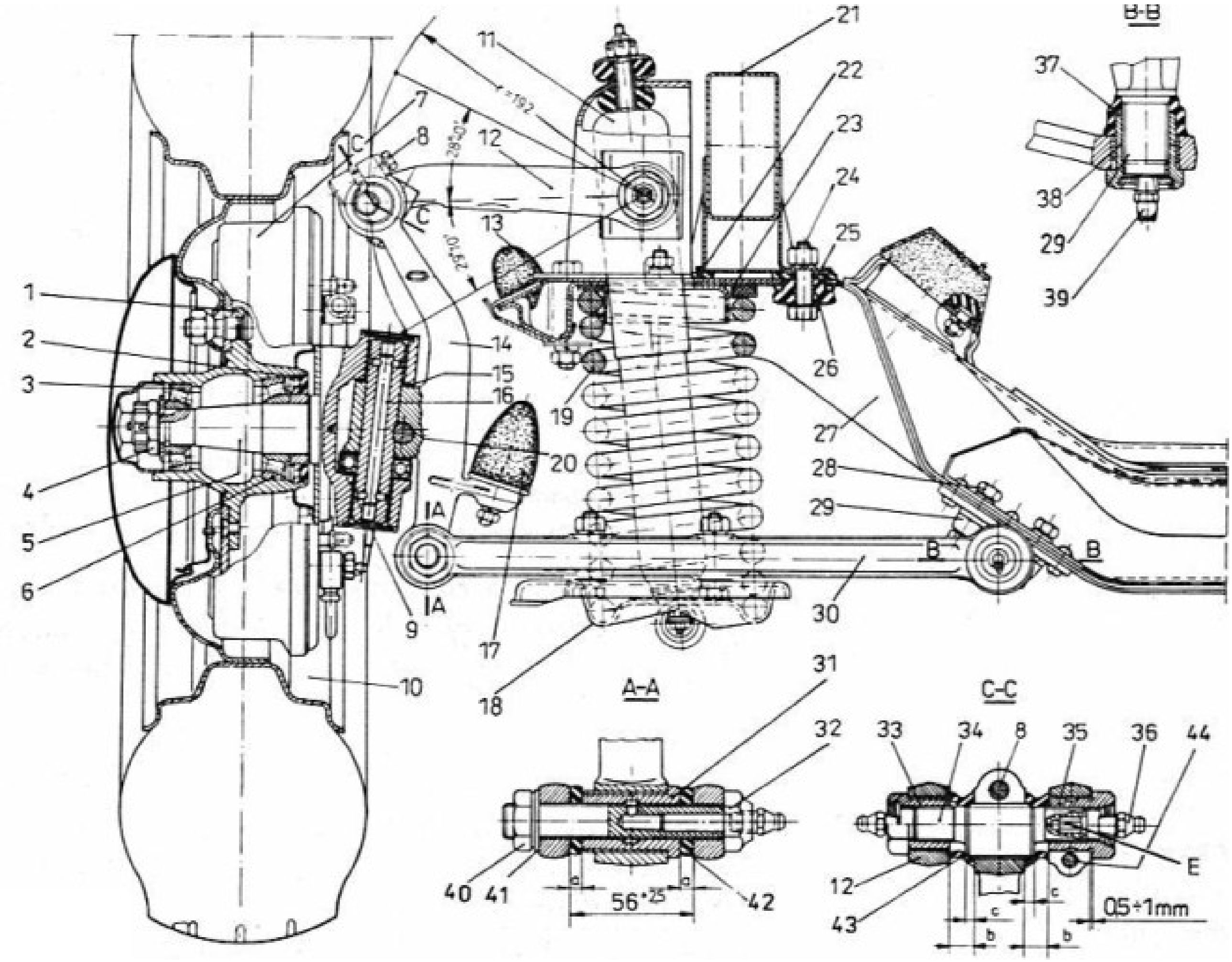
Damaged cab, front and rear suspension, pedal, and brake pump mounting brackets can be straightened out or replaced. Damaged frames should be repaired using commonly known and available repair methods, such as straightening, welding, replacement of supports, sleeves, etc. Replace worn bushings in the pedal bracket with new ones. The sleeves should be pressed in such a way that their front surfaces coincide with the front surfaces (on both sides) of the sleeve welded to the bracket.

After the frame has been repaired or a defect in paint has been found on its surface, the damaged area should be properly cleaned and covered twice with a styreneed phthalic emulsion, symbol 3361-702-990 (without prior priming). The slightly deformed front bumper can be straightened, more distorted or cracked and must be replaced.

4.2 FRONT AXLE AND SUSPENSION

4.2 FRONT AXLE AND SUSPENSION

The front axle with independent wheel suspension for the Żuk car is shown in Figure 4.6. The axle and suspension consists of the beam (27), the lower and upper suspension arms (12, 30), the suspension arms (14), the points, the wheel hubs with bearings and the suspension elements of the screw springs (19) and the telescopic shock absorbers (11). Both sides of the suspension are connected by a stabilizer rod, fixed to the frame and to the spring sockets by means of connectors. The control arms are connected to the beam with connectors and switches by means of threaded bushings and pins.



4.6. Figure: FRONT SUSPENSION (ZAWIESZENIE PRZEDNIE)

1- Wheel hub, 2- Bearing seal 3 - Hub outer bearing (30305 A), 4 - Hub nut (M24x1,5), 5 - Crossover, 6 - Bearings internal, 7 - Brake drum, 8 - Screw M10x40,9 - Crossover bearing (51205 Z), 10 - Running wheel, 11 - Shock absorber, 12 - Upper control arms, 13 - Upper control arm bumper. 14 - control arm switch, 15 - control washers, 16 - switch pin. 17 - control arm connector bumper. 18 - Spring seat, 19 - Suspension spring, 20 - Crossover pin wedge, 21 - Car frame, -22 - Inner washer, 23 - Spring washer, 24 - Front suspension fixing screw, 25 - Resistance sleeve, 26 - Rubber sleeve, 27 - Front suspension bar, 28 - Axis fixing screw for control arms. 29 - lower control arm axis. 30 - lower wishbone, 31 - jack connector sleeve, 32 - lower wishbone pin, 33, 35 - upper wishbone sleeve, 34 - tilt adjustment pin, 36 - grease nipple, 37 - rubber boot, 38 - lower wishbone sleeve. 39 - angle grease nipple, 40 - nut, 41 - washer, 42 - rubber ring. 43 - rubber boot, 44 - turnbuckle E. Wrench socket for adjustment

1- piasta koła, 2.- uszczelniacz łożyska 3 - łożysko zewnętrzne piasty (30305 A), 4 - nakrętka mocowania piasty (M24x1,5), 5 - zwrotnica, 6 - łożysko wewnętrzne pity, 7 - bęben hamulcowy, 8 - Śruba M10x40,9 - łożysko zwrotnicy (51205 Z), 10 - koło jezdne, 11 - amortyzator, 12 - wahacze górne, 13 - zderzak wahacza górnego. 14 - lacznik wahaczy, 15 - podkładki regulacyjne, 16 - sworzeń zwrotnicy. 17 - zderzak łącznika wahaczy. 18 - gniazdo sprężyny, 19 - sprężyna zawieszenia, 20 - klin sworznia zwrotnicy, 21 - rama samochodu, -22 - podkładka wewnętrzna, 23 - podkładka sprężyny, 24 – śruba mocująca przednie zawieszenie, 25 - tuleja oporowa, 26 - tulejka gumowa, 27 - belka przedniego zawieszenia, 28 - śruba mocowania osi dolnych wahaczy. 29 - oś dolnych wahaczy. 30 - wahacze dolne, 31 - tuleja lacznika wahaczy, 32 - sworzeń dolnych wahaczy, 33, 35 - tuleja wahacza górnego, 34 - sworzeń regulacji pochylenia koła, 36 - smarowniczka, 37 - osłona gumowa, 38 - tuleja dolnych wahaczy. 39 - smarowniczka kątowa, 40 - nakrętka, 41 - podkładka, 42 - pierścień gumowy. 43 - osłona gumowa, 44 - śruba ściągająca E. Gniazdo na klucz do regulacji

4.2.1 Front suspension

The front suspension cross-section area is shown in Figure 4.6.

Suspension type	independent on trapezoidal control arms, screw springs and telescopic hydraulic shock absorbers
Adjusting the tilt angle of the wheel Steering angle adjustment Toe alignment adjustment	with eccentric pin (adjustment range max. 6 mm) with an adjustment screw screw screwed into the crossover flange by means of external steering rods, ended with a right-hand and a left-hand thread
Wheel alignment (measured on the wheel rim) Maximum steering angle (left or right) Angle of wheel camber Angle of inclination of the steering kingpin Advance angle of the steering kingpin Maximum swing out of the control arm: - up - bottom Mass of the front linkage Order number Tests and requirements in accordance with	1,5...3,0 mm 30° $0^{\circ}{}^{45}_{-20}$ 6° 0° ± 30' 28°30' 29°10' 107 kg 19-2900002 ZN-82/MPM/06-03272

4.2. Table: TECHNICAL CHARACTERISTICS OF THE FRONT SUSPENSION

■ The front axle beam (27) is the primary load-bearing unit that connects all the components of the front suspension. It is made of 2.8 mm thick steel sheet (locally reinforced with strips). Bottom riveted brackets for lower control arm axles, welded-on engine front suspension brackets, upper control arm bumper brackets, and beam attachment brackets for the frame are riveted into the beam.

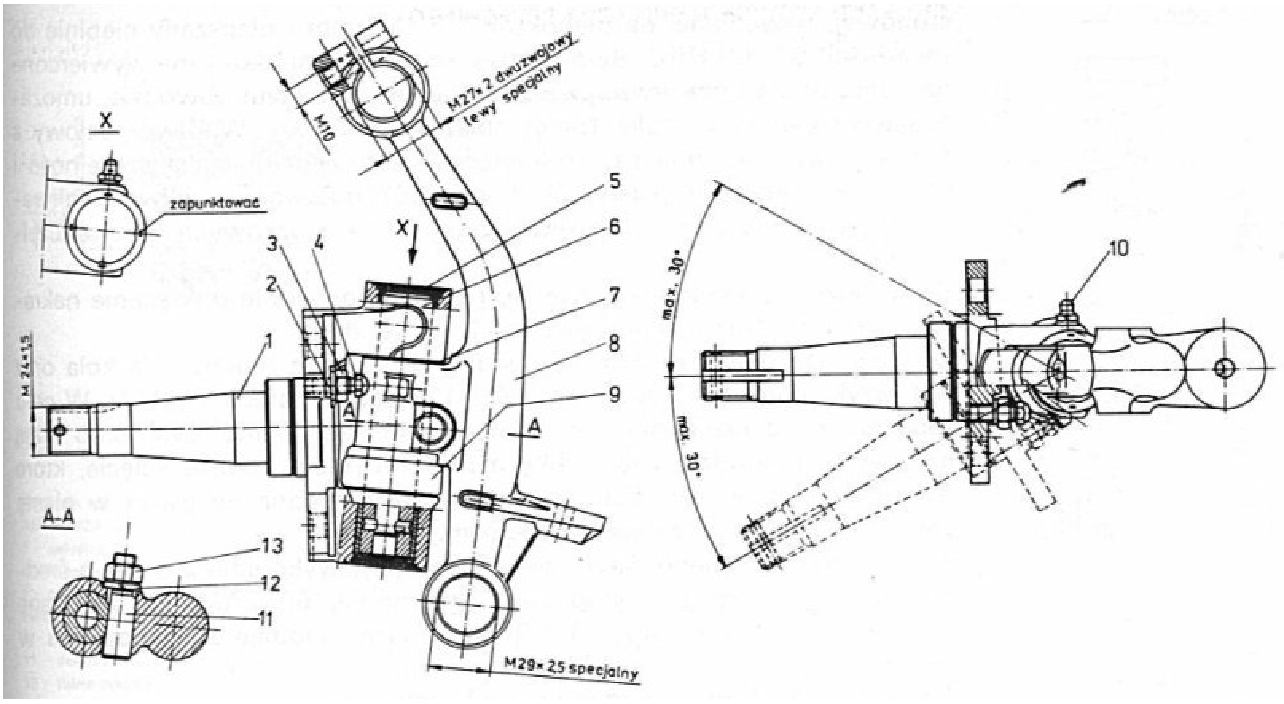
■ The lower control arms (30) consist of two I-section arms forged from alloy steel. At the arm ends there are hubs with special thread M29x2,5 for connection to the control arm axis and M18x2,5 for connection to the control arm connector. Two Ø 10.2 mm holes are made in each arm for attaching the spring seat (18). The lower control arm axles (29), forged from structural steel, have threaded pivots at their ends and two screw-on lugs at each end to the front suspension beam. These axes shall be cyanated to a depth of at least 0,15 mm and heat treated. The upper control arms (12) are pivoted to a support bolted to the beam. The ends of the lower and upper control arms are pivoted to the control arm connector (14) by means of pins and threaded bushings (cross-sectional area A-A, C-C).

The splindle is connected to the steering knuckle with the steering kingpin (16), which is mounted in the sliding sleeves. The vertical load is carried by the crossover thrust bearing (9). The switch pin is secured against rotation by a conical wedge (20) and nut in the control arm connector. The front suspension bar is attached to the car frame from the bottom, through rubber pads (vibration dampening), with ten M12x1,25x48 bolts. 38 sleeves (38) with special external thread M29x2,5 are screwed onto the lower arm axles, using these sleeves are mounted the arms of the lower control arm, whose thread is covered with rubber seals (37). On the outside, the lower control arms are

swiveled onto the pin (32), installed in the control arm connector (14) in the externally threaded bushings. The suspension arm axles are lubricated with grease by grease nipples (36) and channels in the suspension arm axles and pins.

■ The upper control arms (12), forged from carbon steel, consist of two arms which are welded together and machined together. Hood-shaped upper arm brackets, pressed from 4 mm thick steel sheet, to which threaded sleeves for mounting the upper arm pin are welded, are bolted to the beam using four M12x1.5x75 bolts, the control arm is connected to the bracket (rotationally) by means of threaded bolts with special thread M25x2.5, as well as the lower arm.

Hydraulic shock absorbers (11) are fitted inside the support legs on flexible cushions. The control arm connector (14) is connected to the upper control arm with an eccentric pin (34), with a cut-out thread on the pivots. In addition, a hexagonal keyhole for adjusting the tilt angle of the wheel is provided in one pivot. The maximum range for adjusting the tilt angle of the wheel is 6 mm (1°) when the pin is rotated 180°.



4.7. Figure: SPINDLE (ŁĄCZNIK WAHACZY ZE ZWROTNICA)

1 - crossover, 2 - round washer. 3- counter nut, 4- adjustment screw for the steering angle of the front wheels, 5 - blind cover, 6 - switch pin, 7 - adjustment pad, 8 - control arm connector. 9 - crossover thrust bearing. 10 - grease nipple, 11 - conical wedge, 12 - spring pad, 13 – nut

1 - zwrotnica, 2 - podkładka okrągła. 3- przeciwnakrętka, 4 - śruba regulacyjna kąta skrętu kół przednich, 5 - zaślepka, 6 - sworzeń zwrotnicy, 7 - podkladka regulacyjna, 8 - łącznik wahaczy. 9 - łożysko oporowe zwrotnicy. 10 - smarowniczka, 11 - klin stożkowy, 12 - podkladka sprężysta, 13 - nakrętka

Tighten the eccentric pin (after adjusting the tilt angle of the wheel) in the hub with the screw (8) screwed into the coupling. One control arm hub (12) is cut and clamped on the bushing with a screw (44) screwed into the hub flange. All pins and bushings are lubricated with grease nipples (36) and grease channels drilled in the pins.

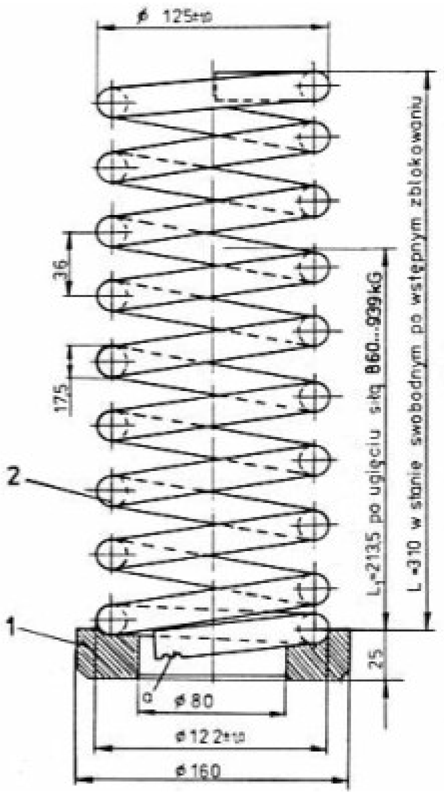
4.2.1 Front suspension

■ The control arm connector (8, Fig. 4.7), forged from alloy steel, is tempered to increase its strength. The lower connecting hub has a hole with special thread M29x2,5 for screwing in the sleeve. In the middle part, the coupling has an overflow with the hub, to which the switch pin (6) is attached by means of a conical wedge (11), secured with a nut (13). On the spring side, the connector has a support to which a rubber bumper is screwed (17, fig. 4.6) which limits the swing of the control arm upwards.

■ The steering knuckle (1, Fig. 4.7) is made of alloy steel and heat-treated to hardness 255...302 HB. The bimetallic bushings of the steering kingpin bearing arrangement (6) are pressed into the steering knuckle hub.

The vertical forces are transmitted by a thrust ball bearing (9), which is fixed on the knuckle pin. The wheel hub (1, Fig. 4.6) is seated on the stub of the steering knuckle on two tapered roller bearings (3.6) sealed on the brake disk side with a seal (2). The inner bearing is supported by the switch journal flange and the outer bearing is pressed against the stop washer (41) with a crown nut (4) - M24x1.5 secured with a pin. The steering knuckle has a forged flange with holes through which a backing plate and a steering knuckle lever are fixed with four screws.

The adjusting screw (4) M8x1x20 with ball head is screwed into the steering flange (fig. 4.7) to limit the steering angle (max. 30°) and secured with a lock nut (3). At the maximum tightening of the wheel, the head of the bolt is supported by the hub protrusion of the rocker arm coupling. In order to eliminate axial play, adjustment washers (7) made of sheet steel are fitted to the switch pin (between the upper switch hub and the coupling hub).



1 - control insert, 2 - spring (a - notches for spring selection groups)

1 - wkładka kontrolna, 2 - sprężyna (a - nacięcia oznaczające grupy selekcyjne sprężyn)

4.8. Figure: FRONT SUSPENSION COIL SPRING (SPREZYNA PRZEDNIEGO ZAWIESZENIA)

4.2.1 Front suspension

The switch pin (6), with a diameter of 25$_{-0,021}$ mm, is made of alloy steel, carburized to a depth of 1,2...1,5 mm and tempered to a hardness of 57...65 HRC. The pin is hollowed in the centre and has two cross holes drilled at the ends and channels around the entire circumference for lubrication of the sleeve (via grease nipples 10). Caps are pressed into the axial hole at both ends of the pin to ensure that they are tight and that the grease is maintained. The outer rings of the tapered roller bearings and the sealant (2) are pressed into the wheel hubs (1, fig. 4.6), which are cast in malleable cast iron.

The clamping of the wheel hub bearings is adjusted by tightening the crown nuts (4), which are secured with lynch pins, as required.

The wheel fixing screws (5 pcs.) are pressed into the hub flange and the brake drum (7) is fastened (to three M8x12 screws). To prevent the screws in the hub flange from rotating, the screw necks have a polygon cut on the circumference and the screw heads have a side cut that is supported by the flange edges. A threaded-in hub cover protects the bearings from dirt.

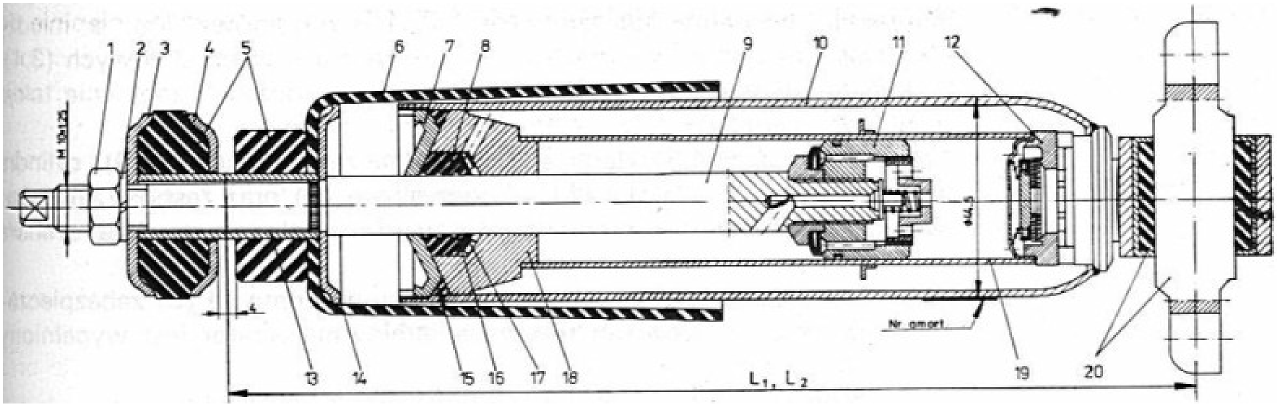
Material	6052 AM
Wire diameter	17,5 mm
Outer diameter of spring	122 ± 1 mm
Height of spring in free state (after initial locking)	310 mm
Spring height after load 860...939 kG	213,5 mm
Number of active coils	7,8
Total number of coils	9,5 + 35 mm
Activated coil pitch	36 mm
Direction of retraction	right
Spring stiffness	100,2 ± 3,1 daN/cm
Permissible deviation of spring from vertical measured on control inserts	max. 10 mm
Spring mass	6,07 kg
Durability	200 000 cycles
Order number of the spring	A03-2902714
Requirements and tests for springs according to	ZN-81/MPM/06-03226

4.3. Table: FRONT SUSPENSION SPRINGS CHARACTERISTICS

Spring length with deflection, mm	**Required value of controlled force, daN**	**Selection group**	**Selection group identification**	
			notch marking	**color marking**
213,5	860… 880	I	1 incision	yellow strip
	880...900	II	2 incisions	green strip
	900...920	III	3 incisions	brown strip
	920...939 *	IV	4 incisions	white strip

* For cars with a 4C90 engine.

4.4. Table: SPRING SELECTION GROUPS



4.9. Figure: FRONT SHOCK ABSORBER

1 - nut, 2 - spring washer, 3.4 - cups, 5 - rubber cushion, 6 - rubber cushion, 7 - cylinder nut, 8 - piston rod gasket. 9- piston rod, 10 - external cylinder. 11 - piston, 12 - bottom valve. 13 resistance sleeve, 14 resistance bowl, 15 nut gasket, 16 gasket plate, 17 guide channels, 18 piston rod assembly, 19 internal cylinder. 20 - shock absorber lower attachment pin, 4 - compressed length, 42 - stretched length (stroke=155 mm)

1 - nakrętka, 2 - podkładka sprężysta, 3.4 - miseczki, 5 - poduszka gumowa, 6 - osłona gumowa, 7 - nakrętka cylindra, 8 - uszczelka tłoczyska. 9- tłoczysko, 10 - cylinder zewnętrzny. 11 - tlok, 12 - zawór dolny. 13 - tuleja oporowa, 14 - miska oporowa, 15 - uszczelka nakrętki, 16 - płytka uszczelki, 17 - kanałek prowadnicy, 18 - zespół prowadnicy tloczyska, 19 - cylinder wewnętrzny. 20 - sworzeń dolnego mocowania amortyzatora, 4 - długość w stanie ściśniętym, 42 - długość w stanie rozciągniętym (skok=155 mm)

■ Front suspension springs (Fig. 4.8), made of 17,5 mm diameter wire, made of 60S2AM spring alloy steel, are tempered to 45...49 HRC hardness. Springs are shot peened to increase their fatigue strength.

The practicalities of springs are given in Tables 4-3 and 4-4.

Depending on the control loading, the springs are selected into four groups marked with notches (a, Fig. 4.8) or coloured strips, respectively. Replacement springs are marked with notches only.

Depending on the control loading, the springs are selected into four groups marked with notches (a, Fig. 4.8) or coloured strips, respectively. Replacement springs are marked with notches only.

Only springs of one selection group are mounted on one car, whose length difference in the free state must not exceed 10 mm, and the difference in control forces of both springs is not greater than 200 N.

The top coil of the spring is bent so that its front surface is perpendicular to the axis of the spring. The end of the lower coil is straight and extends beyond the outer diameter of the spring. The lower spring seat is made according to the shape of this coil, which ensures proper seating and protection of the spring against rotation. Each spring in the production process is compressed until it locks in place at least three times, in order to deposit the coils and obtain a permanent characteristic.

The height of the locked spring, measured from the control insert, is 166 mm. The spring stiffness is measured by bending it in the range of 188,5...238,5 mm of spring length. The spring stiffness thus measured shall be 100,2 ± 3,0 daN/cm. The springs shall have a service life of at least 200 000 cycles.

4.2.1 Front suspension

The springs are protected against corrosion by phosphating, passivating, priming with chromate primer and painting by immersion in black chloride enamel. On the arms of the lower control arms (Fig. 4.6), spring seats (18) are fixed on the underside (with four screws), pressed from a 3 mm thick steel sheet. The shock-absorber is attached to the spring seat using two M8x1x25 bolts, which are permanently pressed into the seat. The spring seat has a 53 mm centre hole (for removing the shock absorber from the suspension), four 10 mm Ø holes for attaching the lower control arms and an eye with a 11.5 mm Ø hole for attaching the stabilizer connector.

Hydraulic shock absorbers double acting (Fig. 4.9), type 28 are designed for damping vertical vibrations of front suspension and running wheels.

At the bottom end of the shock absorber there is an ear in which a special pin with a rubber-steel sleeve is fitted, used to attach the shock absorber to the spring seat.

The shock piston rod (9) is screwed to the upper arm bracket on the rubber cushions (5) with a nut (1), secured with a spring washer (2).

A rubber cushion (5) is fitted between the two elements and a rubber cushion in the steel cups (3.4) is fitted between the brackets and the nut to provide a flexible connection between the shock-absorber and the support. The spacer sleeve (20) reduces the preload of the piston rod cushions.

The shock-absorber (Figure 4.9) consists of an outer cylinder (10), an inner cylinder (19), a piston (11) with a piston rod (9) and a piston valve assembly, a guide valve and a lower valve at the bottom of the inner cylinder.

At the top of the piston rod there is a rubber cover (6) which prevents the shock absorber from becoming dirty. The shock-absorber is filled with 180 cm^3 of AT oil.

The characteristics of the front shock absorbers are given in Table 4-5.

Type	28, hydraulic, telescopic double acting
Number of suspension dampers	2 pieces
Diameter of the outer cylinder (outer cylinder)	44,5 mm
Length of shock absorber:	
- overstretched	447 ± 3mm
- retracted	292 ± 3 mm
Total stroke of the shock absorber	155 mm
Amount of oil in the shock absorber *	180^{+10} cm^3
Oil grade	AT oil according to BN-72/0535-28
Control characteristics of the shock absorber:	
- stroke of the control device (S)	101,6 mm
- frequency of appliance	1,733 Hz 0,15 Hz
- rebound force (P_0)	160 ± 18 daN 23 daN
- deflection force (P_u)	86 ± 11 daN 18 daN
Test temperature	20 ± 5°C
Shock absorber weight	1,8 kg
Durability of shock absorbers	750 000 duty cycles
Requirements and tests according to	BN-77/3612-09
Order number	501.1.28.00
Manufacturer	F.A. Krosno

* There is no oil replenishment or change in the shock absorbers during the entire life of the vehicle.

4.5. Table: FRONT SHOCK ABSORBERS CHARACTERISTICS

During the operation of the shock absorber, two main strokes occur: bending stroke and rebound stroke.

The oil flow in the shock absorber is one-way. In the no-load position, the oil fills the entire working space of the inner cylinder above the piston and under the piston, and partly the compensation space of the outer cylinder.

During the slow compression of the damper, oil flows through the piston gaps (11) and dampens the deflection force through the piston channels into the space above the damper. The piston valve (11) opens when the deflection force is applied rapidly, and oil flows from the piston space into the piston space (through the deflection joints in piston 11) and the deflection gap between the plate and nut, damping the deflection force. At the same time, the oil is pressed into the equalising space through the slots in the lower valve body (12).

The values that affect the damper performance are factory set and cannot be adjusted by the vehicle user.

Periodically, after 40 000 km and if the shock absorbers are found to be working poorly, their characteristics should be checked at the service station.

The regeneration of shock absorbers is carried out by the manufacturer (F.A. Krosno) according to his own technology.

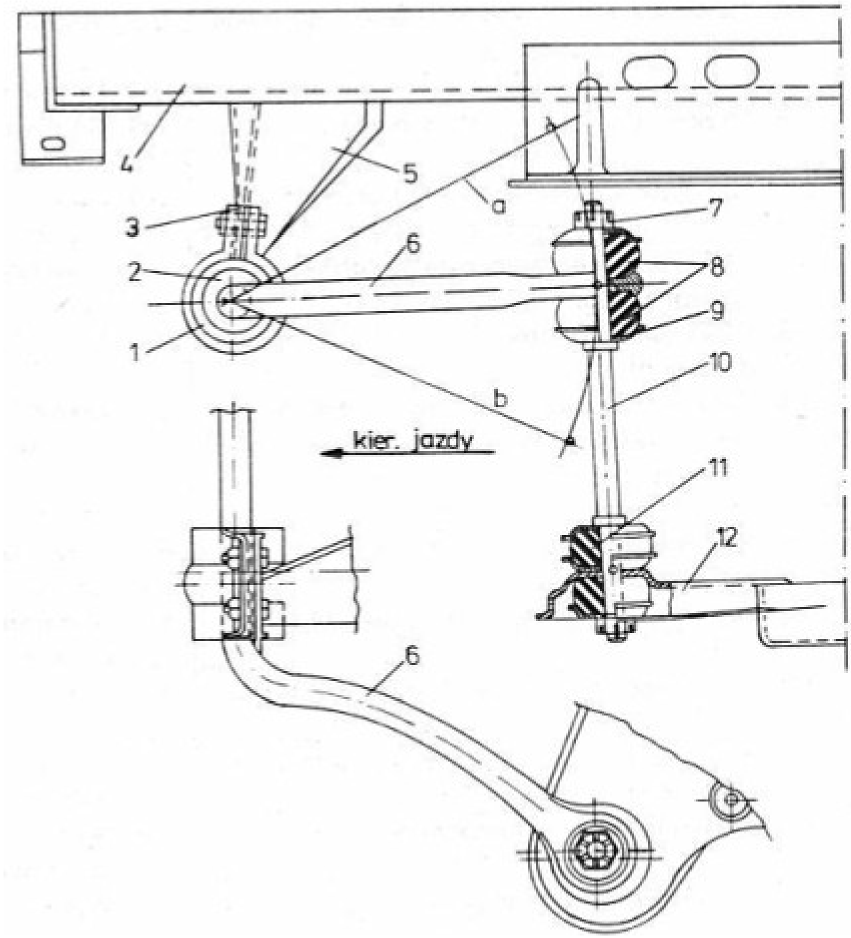
The damping of the deflection and rebound forces by the damper is dependent on the adjustment of the piston and rebound valves and the size of the slots and flow channels in these valves. The performance characteristics of the shock absorber (Table 4-5) are determined by the dependence of the deflection and rebound forces on the spring travel of the shock absorber.

4.2.2 Anti-roll bar

The stabiliser (anti-roll bar, Fig. 4. 10) is a steering rod (6) with a diameter of 17.5 mm, made of 60S2A spring steel, tempered to 42...48 HRC. The rod is 960 2.5 mm long and 170 2.5 mm high (bent). At the ends of the rod there are forged flat ears with a 31 mm diameter socket and 0 16 mm holes. These eyes have stabilizer connectors (10) attached at the other end (in the same way) to the spring sockets. The torsion bar is flexibly attached to the vehicle frame supports in two rubber bushings and brackets (1), which are bolted to the supports.

The stabiliser couplings (10), made of a steel bar with a diameter of 10 mm and a length of 222 mm, have forged bowl retaining flanges (9) and threaded ends (thread M11x1 with a length of 15 mm). The lower end of the anchor is seated on the rubber pads (2) in the spring seat of the front suspension. The flexible way of fastening the connector at both ends allows its angular deflection at both fixing points. A floating wheel swings out the other wheel via the stabiliser link and bends the suspension spring. As a result, the tilt of the body is reduced. The vehicle's traffic is therefore becoming smoother, which significantly improves driving conditions, especially in bends and on uneven road surfaces.

4.2.2 Anti-roll bar



1 - pole bracket, 2 - rubber cushion, 3 - bracket, 4 - car frame, 5 - stabilizer bracket, 6 - stabilizer rod, 7 - crown nut (M11x1), 8, 11 - rubber cushions, 9 - bowl, 10 - stabilizer connector, 12 - spring socket a, b - stabilizer rod axis in its upper and lower extremity position.

1 - obejma drążka, 2 - poduszka gumowa, 3 - obejma, 4 – rama samochodu, 5 - wspornik stabilizatora, 6 - drążek stabilizatora, 7 - nakrętka koronowa (M11x1), 8, 11 - poduszki gumowe, 9 - miseczka, 10 - łącznik stabilizatora, 12 - gniazdo sprężyny a, b - oś drążka stabilizatora w jego górnym i dolnym skrajnym położeniu

4.10. Figure: ANTI-ROLL BAR (STABILIZATOR PRZEDNIEGO ZAWIESZENIA)

4.2.2 Anti-roll bar

Trouble	Reasons	Method of repair
1. High torsional resistance on front wheels.	1.1 Ungreased steering kingpins or steering rod joints.	1.1 Lubricate these parts.
	1.2. the bushing of the steering knuckle pins is seized.	1.2 Lift the front of the vehicle and check that the steering knuckles (after lubrication) rotate freely; replace any blurred parts if necessary.
	1.3. incorrect wheel alignment.	1.3 Check and adjust if necessary.
	1.4 Inadequately set advance angles of the steering kingpins (too large).	1.4 Check and, if necessary, adjust the steering angle of the steering knuckles.
	1.5 Too low a tyre pressure on the front wheels.	1.5 Check the pressure and top up if necessary.
	1.6. bearing play too small or seized in the steering transmission.	1.6 Adjust the clearances in the gearbox bearings or replace the seized bearings.
2. Torsional vibration of the front wheels around the steering knuckle pins	2.1. dynamically unbalanced wheels.	2.1 Balance the wheels in the ASO.
	2.2 Incorrect setting of the advance angle of the steering kingpin.	2.2 Check and adjust if necessary.
	2.3. incorrect wheel alignment.	2.3 Check and, if necessary, adjust.
	2.4 Excessive clearance in the hub bearings.	2.4 Check and adjust if necessary.
	2.5 Incorrect pressure at one of the front wheels.	2.5 Check and refill the pressure.
	2.6 Damaged or excessively worn suspension arm thread sleeves.	2.6 Replace damaged or worn parts.

4.6. Table: FRONT SUSPENSION TROUBLESHOOTING

2. Torsional vibration of the front wheels around the steering knuckle pins	2.7 Excessive play in the steering knuckle pin.	2.7 Replace the bearing sleeves.
	2.8. front shock absorbers damaged.	2.8 Check the shock absorbers and replace if necessary.
	2.9. incorrect alignment of the front wheels.	2.9 Check wheel alignment and adjust.
3. Vibration of the wheels in the vertical plane	3.1. unbalanced wheels or tyre fitted incorrectly.	3.1 Balance the wheels or fit the tyre correctly.
	3.3 Deformed wheel rim or damaged tyre.	3.3 Repair or replace damaged parts.
	3.4. weakened suspension screw springs.	3.4 Check the springs and replace them if necessary.
	3.5 Different tyre pressures on both wheels of the same axle.	3.5 Check and equalise the pressure in the wheels.
4. The vehicle is "pulling" sideways when travelling straight ahead.	4.1 Insufficient or unequal wheel pressure.	4.1 Check and correct the pressure at all wheels.
	4.2 Incorrect setting of the front wheel angles.	4.2 Check and adjust the setting angles of the wheels and steering knuckles.
	4.3 Curved steering knuckle, coupling or control arm.	4.3 Check defective parts, replace them.
	4.4. incorrect characteristics of one of the suspension springs.	4.4 Check the characteristics and replace the incorrect spring.
	4.5. curved car frame.	4.5 Check and, if necessary, straighten the frame (after removal), or replace it.
	4.6 Incorrect adjustment of one wheel bearing.	4.6 Adjust the bearings on both wheels.
	4.7. incorrect adjustment of the brake of one wheel (locking).	4.7 Adjust the brakes on all wheels.
	4.8. one shock absorber damaged.	4.8 Check the characteristics of both shock absorbers and replace if necessary.
5. loud (noisy) front suspension operation	5.1 Insufficient lubrication or too much clearance in the front wheel bearings.	5.1 Rinse, lubricate and adjust bearing play, replace damaged bearings.
	5.2 Excessively worn loader arm thread sleeves.	5.2 Replace worn bushings.
	5.3 Damaged or loose stabiliser couplings.	5.3 Damaged or loose stabiliser couplings.
	5.4 Excessively worn steering knuckles.	5.4 Replace worn bushings.
	5.5 Loose wheel fixing nuts.	5.5 Tighten the nuts to the correct torque.
	5.6 backing plate not tightened.	5.6 Tighten the loose screws on the disc.
	5.7. shock absorbers loose or damaged.	5.7 Tighten the screws securing the shock absorbers and replace damaged parts.
	5.8. play in the ends of the steering rods or on the support for the intermediate rods.	5.8 Tighten the crown nuts on the supports and the ball pins of the ends.
6. wheel hubs become excessively hot	6.1 Over-tightened nuts on the stubs of the switches.	6.1 Loosen the nuts slightly and adjust the axial clearance of the bearings (max. 0,1 mm).
	6.2 Insufficient lubrication of bearings.	6.2 Check the grease in the foam and top it up if necessary.

4.2.3 Repair of front suspension

Deficiencies in the front suspension (Table 4-6) mainly affect the operation of shock absorbers, springs, control arms, wheel and steering knuckle elements and the stabiliser.

Improper operation of the shock absorbers can be observed:

- excessive rocking of the vehicle (especially on bends and after passing through obstacles); with proper damping, the number of variations of the vehicle body should not exceed 2...3;

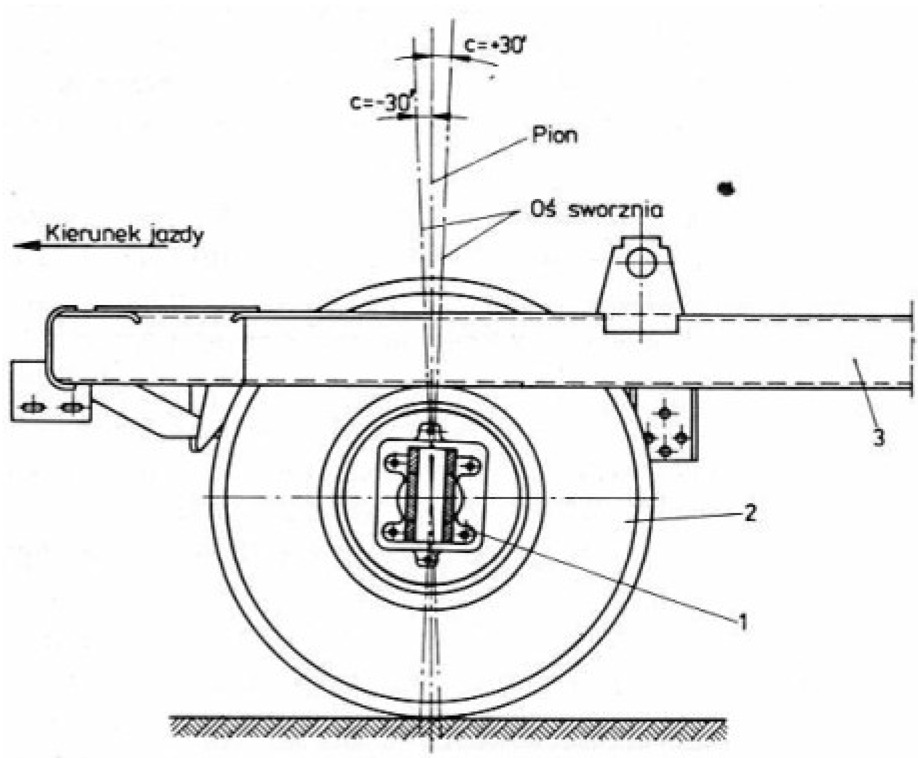
- difficult cornering;
- oil spills.

Checking and adjusting the angles of the front wheels. The wheel alignment angles (Fig. 4.11...4.13) shall be checked and adjusted on the vehicle under full load when the lower suspension arms and the geometric axles of the steering knuckles are parallel to the ground. The values of these angles are given in Section 4.2.1.

It is recommended to measure the angles of the wheels using special diagnostic instruments (at the operating station). The permissible difference in inclination angles between the left and right wheels shall not exceed 30'.

The eccentric threaded pin of the upper swing arms is used to adjust the tilt angle of the wheel, the steering kingpin and the advance angle of the steering kingpin (34, Fig. 4.6). Turning the pin moves the upper end of the control arm connector (14) forward or backward while the upper end of the control arm (14) approaches or moves away from the vehicle's longitudinal axis. The camber angle and the camber angle of the steering kingpin are closely interlinked and change at the same time during adjustment. One full turn of the pin changes the advance angle of the kingpin by 1°30'. Turning the pin clockwise increases and counterclockwise decreases the advance angle of the kingpin.

The maximum range of wheel tilt adjustment (6 mm) is obtained by turning the pin half a turn (180°), which changes the tilt of the wheel by 1°. Full rotation of the eccentric pin (34) does not change the tilt angle, but only changes the preview angle of the knuckle pin.



1 - steering kingpin, 2 - steering wheel, 3 - car frame

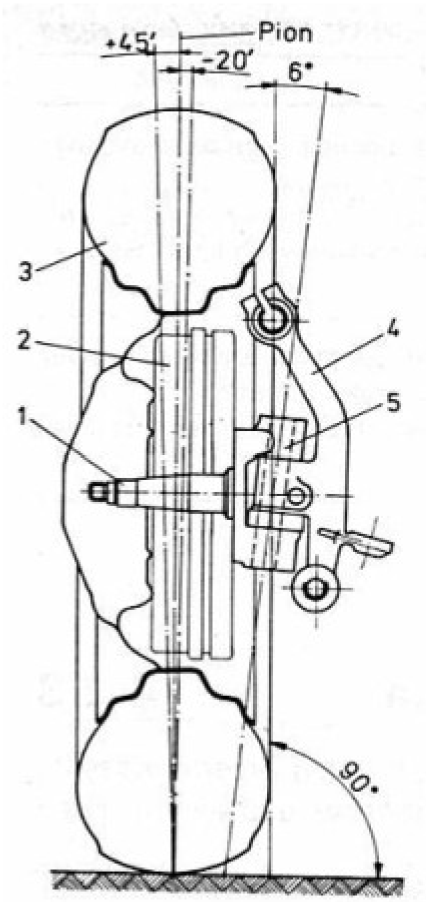
1 - sworzeń zwrotnicy, 2 - koło jezdne, 3- rama samochodu

4.11. Figure: ADVANCE OF THE STEERING KINGPIN (KAT WYPRZEDZENIA SWORZNIA ZWROTNICY)

4.2.3 Repair of front suspension

Before adjusting the wheel alignment angle, check the play in the front wheel hub bearings and adjust it if necessary. If the bearing play is detected by moving the wheel in a plane perpendicular to its axis (when the front of the vehicle is raised), or if the wheel hubs heat up while driving and grease is leaking, adjust the play as follows:

- raise the front of the vehicle,
- remove the wheel cover and unscrew the hub cover,
- remove the pin from the kingpin of the steering knuckle,
- turn the wheel and evenly tighten the crown nut (4, Fig. 4.6) to a torque of 100...120 N-m until there is a clear resistance of the bearing, then unscrew it by 1/6 turns and secure it with a pin so that the axial clearance of the bearing does not exceed 0.1 mm (turning the wheel during adjustment ensures correct positioning of the bearing shafts),
- screw on the hub cover and put on the hub cap,
- check the wheel hubs for excessive heat after driving several kilometers.



1 - steering knuckle, 2 - brake drum, 3 - drive wheel, 4 - control arm connector. 5 - switch pin

1 - zwrotnica, 2 - bęben hamulcowy, 3- kolo jezdne, 4 - łącznik wahaczy. 5 - sworzeń zwrotnicy

4.12. Figure: TILT ANGLE OF STEERING KINGPINS AND FRONT WHEELS

Before starting to adjust the wheel settings, prepare the car as follows:

- adjust the play in the front wheel hub bearings,
- check that there is no pin slack in the control arm bushings,

- check and remove play in the steering mechanism and on the ball pins of the steering rods,
- place the vehicle on a horizontal plane and check and refill the tyre pressure to the required value (front wheels 0,25 MPa; rear wheels 0,32 MPa),
- load the vehicle completely (the lower control arms should be parallel to the ground under this load),
- align the wheels for straight-ahead travel.

The preview angles of the steering kingpin and the steering kingpin (Fig. 4.11 and 4.12) must be adjusted as follows:

- unscrew the clamping screw (8, Fig. 4.6) of the control arm connector to loosen the upper link pin,
- remove the grease nipple from the front bushing (35) of the upper arm and insert the wrench into the hexagon socket of the pin (34),
- turn the wishbone pin with the key to obtain the required advance angle for the steering kingpin and tilting pin,
- tighten the clamping screw (8) and screw in the grease nipples at the front,
- check that the wheels have been adjusted correctly.

Do not turn the upper link pin fully, but leave a reserve of approx. 45°. In the absence of this reserve, the pin's face may lean against the bushing's face (when the suspension arms move), causing the pin to rotate in the coupling's upper hub (14, Figure 4.6), affecting the position of the front wheels.

After adjusting the angle of rotation of the wheels, determine the maximum steering angle (30°) using the screws (buffers). For this purpose, a ball head adjusting screw (bumper) (4, Fig. 4.7), screwed into the steering knuckle flange, is used. The measurement and adjustment of the steering angle shall be carried out as follows:

- place the swivel base with the front-wheel graduation in place,
- align the front wheels for straight ahead travel,
- loosen the counter nut (3) securing the stop screw of the steering knuckle,
- turn the front wheels so that the inner wheel is turned at an angle of 30° (graduated on the swivel base),
- by turning the adjusting screw (4), bring its tba into contact with the bumper on the control arm connector,
- secure the stop screw with the lock nut (3),
- turn the wheels in the opposite direction and limit the rotation angle of the other wheel in the same way.

4.2.3 Repair of front suspension

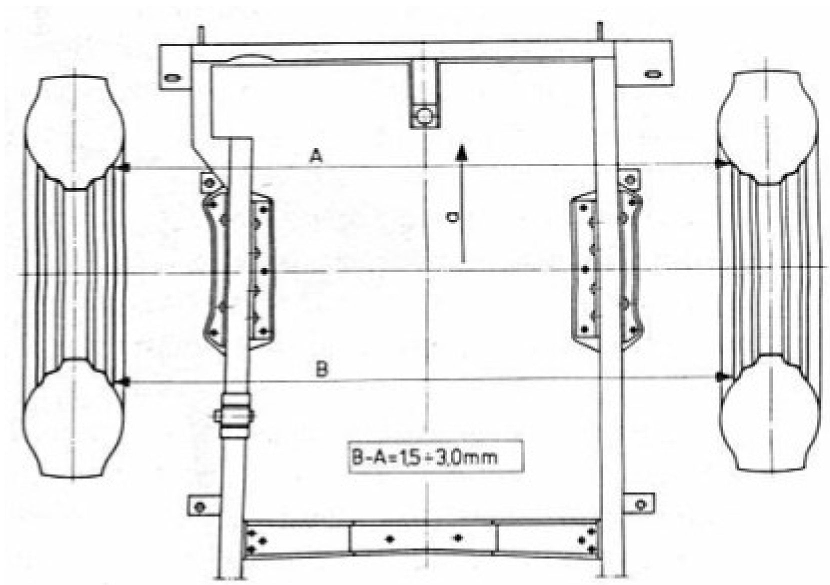
In the absence of pitchable swivel plates, the steering angle can be measured on the steering wheel using a suitable protractor. In this measurement, the steering angle (30°) corresponds to a rotation angle of the steering wheel of approximately 630° from the straight-ahead position of the steering wheel.

Checking and adjusting the alignment of the front wheels. This should be done during maintenance as well as in case of increased and uneven tyre wear and driving difficulties.

Before adjusting the toe in:

- lift the front wheels (with the jack) and check the lateral runout of the rim by turning them by hand, which should not be more than 1.2 mm (after adjusting the play in the hub bearings),
- lower the front wheels to the ground and load the vehicle with full load,
- eliminate any slack in the joints of the centre steering rod. It is recommended to set the alignment of the front wheels with optical instruments, e.g. PK0-1, in the ASO.

The following is a simplified method of measuring the wheel alignment, intended for users who will carry out this operation on their own.



A- measure the distance between the wheel rims at the front of the vehicle at the wheel axle height,
B- measurement of the distance between the wheel rims behind the front axle at wheel height
Wheel alignment=B-A=1,5...3,0 mm

A- pomiar odległości między obręczami kół z przodu samochodu na wysokości osi kól,
B- pomiar odległości między obręczami kół za osią przednią na wysokości osi kól
Zbieżność kól=B-A=1,5...3,0 mm

4.13. Figure: FRONT WHEEL ALIGNMENT MEASUREMENT

The alignment of the wheels (Figure 4.13) shall be checked when the wheels of the vehicle are in the straight-ahead position on a horizontal and smooth surface when fully loaded. Then roll the car a few metres forward to balance the front suspension components. The measurements determining the wheel alignment must be taken at the same points on the wheel rims (at the height of the centre of the wheel). First measure the distance (B) between the edges of the rim at the rear of the wheel axle (mark the measurement points with chalk on the rims); then roll the vehicle forward so that the wheels turn half a turn (180°) and the measurement points on the rims are at the front of the axle and measure the distance (A).

The difference between the Bi A dimensions determines the alignment of the car's front wheels. The correct wheel alignment must be B-A= 1,5...3,0 mm (for the tapering test 180° - lateral runout has

no effect on the measurement results). If the measured wheel alignment does not correspond to these values, it must be adjusted as follows:

- remove the lynch pins from the bolts in the clamping brackets (12, Fig. 5.1),
- turn the left outer rod (18) (with pipe wrench) by the same angle (in opposite directions) to obtain the required wheel alignment.

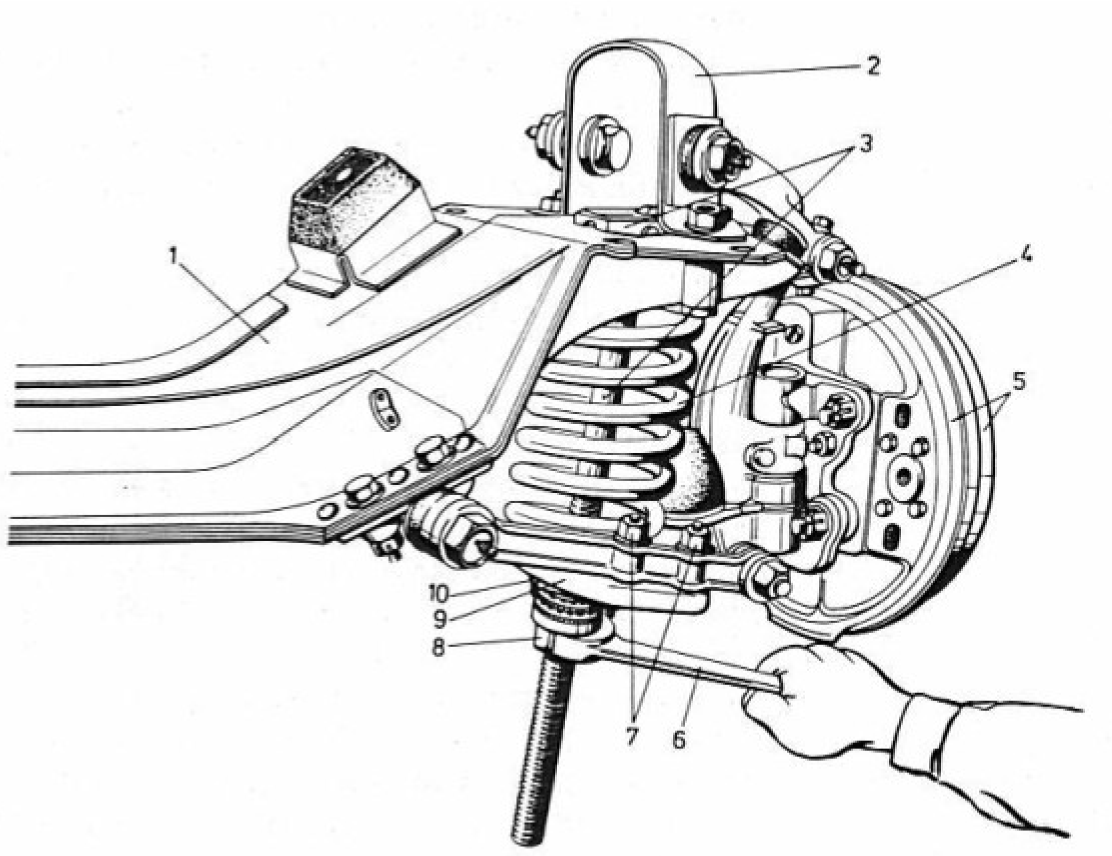
When rotating clockwise (from the centre of the car's longitudinal axis), the rods are shortened and when rotating counterclockwise, they are elongated. After adjustment, the intersections in the rods (18) must be either set to the position of the ends as shown in Figure 5.1 or set at an angle of 180°. The permissible deviation of the intersections from the vertical must not exceed ± 30°. At the same time, the brackets (12) should be positioned approximately 10 mm from the end of the rod, and the screws in the clamping brackets should be positioned with Ibams on the side of the centre rod (6, fig. 5.6).

After adjusting the wheel alignment, tighten the clamps by tightening the crown nuts to 15...25 N·m and secure with new pins.

The correct adjustment of the front suspension wheels must be checked during a trial run, during which attention must be paid to the straight-ahead return of the wheels, proper damping of vibrations and directional maintenance.

1 - beam, 2 - upper control arm bracket, 3 - instrument (5230075). 4 - spring, 5 - right brake disc, 6 - flat wrench S=32, 7 - nut, 8 - instrument nut, 9 - spring socket, 10 - instrument socket

1 - belka, 2 - wspornik wahacza górnego, 3 - przyrząd (5230075). 4 - sprężyna, 5 - tarcza hamulcowa prawa, 6 - klucz płaski S=32, 7 - nakrętka, 8 - nakrętka przyrządu, 9- gniazdo sprężyny, 10 - gniazdo przyrządu

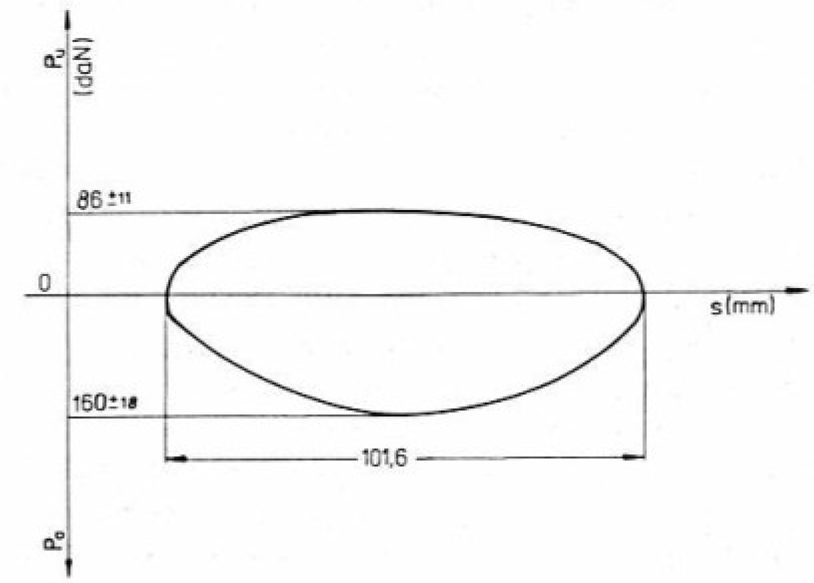


4.14. Figure: PULLING OUT THE SPRINGS FROM THE FRONT SUSPENSION

4.2.3 Repair of front suspension

To check the characteristics of the front suspension spring, the shock absorber must be removed and replaced by a spring compressive device (3, Figure 4.14).

After compressing the spring by tightening the nut (8), unscrew the nut (7) of the spring seat and remove it together with the lower seat (9) and the device. After washing the spring, e.g. in caustic soda solution, it shall be visually checked for damaged coils, cracks or permanent deformations and the deflection force of the spring checked. The characteristics of the proven spring shall be as given in Table 4-3 and springs which do not meet these requirements shall be replaced with new springs (not to be repaired). For the previous suspension after repair, springs shall be fitted whose length in the free condition does not differ by more than 10 mm and whose control forces do not differ by more than 200 N from each other. To check the characteristics of the shock absorbers or to replace them, unscrew the nut of the top attachment of the shock absorber to the upper control arm bracket, then the two nuts of the lower control arm, and then exit the shock absorber downward through the hole in the spring seat.



P. - deflection force, P, - rebound force, S - stroke of shock-absorber tester slider

P. - siła ugięcia, P, - siła odbicia, S - skok suwaka urządzenia do badania amortyzatorów

4.15. Figure: DIAGRAMS OF DAMPING FORCES ON FRONT SHOCK ABSORBERS

The dependence of the deflection and rebound forces on the shock stroke is a characteristic of the shock absorber (Fig. 4.15).

It is made in the ASO on a special crankshaft device, e.g. SA-100, driven by an electric motor. The nominal P_u deflection force, measured at a shock stroke of 101,6 mm and a crankshaft speed of 104 rpm, shall be 86 ± 11 daN and the deflection force P_0. at the same measurement parameters shall be 160 ± 18 daN. The graph made by the device should be compared with the standard graph.

A shock-absorber shall be regarded as technically sound if the damping force values for the deflection movement are within the tolerance limits given in the shock-absorber characteristics. If the damping force drop of the tested damper exceeds the limits, the damper shall be replaced.

Hydraulic shock absorbers can be tested more quickly and accurately on a state-of-the-art BOGE system using the vertical forced vibration method of the wheels (and shock absorbers) installed in the vehicle.

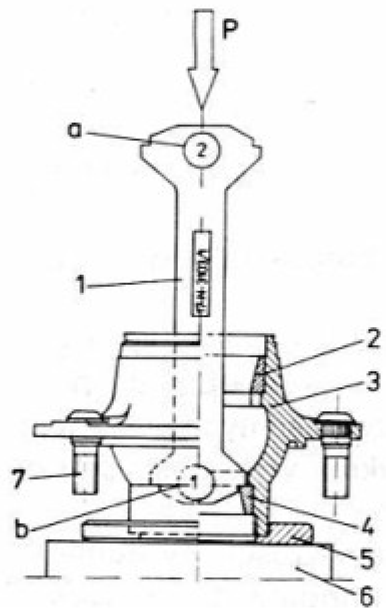
4.2.3 Repair of front suspension

These tests are carried out on a wheel-by-wheel basis. The quality of the shock absorber under test shall be measured by the maximum value of the vibration amplitude plotted by the recording mechanism, which shall be compared with the calibration graph established by the shock absorber manufacturer. BOGE devices are equipped with: ITS, Pimot Warszawa and FS Lublin as well as modern Polmozbyt service stations. Alternatively, you can check the efficiency of the shock absorbers (on your own) by driving through an obstacle in the form of a shallow furrow or a small threshold. If the car body makes no more than 2 to 3 swings when passing through an obstacle, the performance of the shock absorbers shall be considered good.

The shock absorbers should be replaced if more swings are detected and if it is difficult to drive the vehicle over bumpy roads or corners.

The front (type 28) and rear shock absorbers do not have to be refilled or replaced during their entire service life. In the event of a loss of damping or oil leakage, the shock absorbers must be replaced or reconditioned.

The design of the shock absorbers ensures correct operation for at least 40000 km of vehicle mileage, after which the characteristics of damping forces should be checked. After a mileage of 80000 km, the shock absorbers must be replaced.



4.16. Figure: EXTRUSION OF THE OUTER RINGS BEARING FROM THE FRONT WHEEL HUB

1 - bearing drift (17 N-3103/1).
2- the outer ring of the rear bearing.
3 - wheel hub,
4 - outer ring of the front bearing.
5 - the stop ring (5490155) of the device,
6 - locksmith's plate,
7 - wheel fixing bolt,
a - end for breaking out the rear bearing,
b - the impactor tip for the front bearing,
P - Forcing

1 - wybijak łożyska (17 N-3103/1).
2- pierścień zewnętrzny łożyska tylnego.
3 - piasta koła,
4 - pierścień zewnętrzny łożyska przedniego.
5 - pierścień oporowy (5490155) przyrządu,
6 - płyta ślusarska,
7 - śruba mocowania koła,
a - końcówka do wybijania łożyska tylnego,
b - końcówka wybijaka do wybijania łożyska przedniego,
P - działanie siły

Repair of front linkage. The front suspension (including beam) can be removed from the vehicle after removing the engine and disconnecting the steering and brake hoses. Smaller repairs (if the suspension bar is not damaged) can be carried out on a complete vehicle (replacement of shock absorbers, springs, control arms, switches, etc.).

Check the front wheel hubs (3, Fig. 4.16) for external damage or cracks and check the seating of the wheel bolts (7) and bearing outer rings.

If the screws are damaged (worn-out thread or deformation), they are replaced by pressing on the press and forcing new ones in.

If the bolt holes are broken or damaged (no proper bolt press in the hub), replace the hub.

The diameters of the seats for the outer rings (2.4 Fig. 4.16) of the bearings are also checked; the diameters for the inner bearing (2) must not exceed 71,99 mm (nominal diameter $72^{-0.021}_{-0.051}$ mm), and for the outer bearing (4) must not exceed 61,99 mm (nominal diameter $62^{-0.021}_{-0.051}$ mm).

The sealant (2, Fig. 4.6) must be replaced every time the hub is removed.

For verification and evaluation, the switches must be removed from the front suspension of the vehicle, if necessary with a rocker arm connector (3, Fig. 4.17). After punching the steering kingpin with the special drift (2) and disconnecting it from the coupling (3), carefully clean the steering knuckle with kerosene or solvent.

The crossovers are checked for cracks, deformations, thread damage, cuts, crushing or other damage to the working surfaces (visually inspected or magnetically inspected). In case of a crack (or even suspicion), the steering knuckle should be replaced with a new one for safety reasons. If the thread of M24x1.5 kingpin (1, Fig. 4.7) is damaged, the kingpin diameter above the nominal dimensions (Ø $25^{-0.013}_{-0.034}$ mm and Ø $35^{-0.013}_{-0.038}$ mm) or the knucklep must be used for scrap.

If the diameter of the hole in the pin bushings exceeds 25,040 mm, replace the bimetallic bushings of the steering knuckle with new ones. After pressing the new bushings into the crossover, the nominal size Ø $25^{+0.020}_{+0.008}$ mm must be drilled. Replace the switch pin (6, Fig. 4.7) if it has dents, excessive wear or if it is less than 24,9 mm in diameter at any point.

The pinch wedge in the coupling (11) must be replaced every time the pin is replaced.

The rocker arm coupling (8, fig. 4.7) is used in the same way as the crossovers, including the use of a magnetic defect scope.

The hole Ø $25^{+0.010}_{-0.023}$ mm in which the steering kingpin is pressed is not repairable. If this hole shows signs of wear, the coupling must be replaced.

The steering knuckle bearing (9, Fig. 4.7), which is ball bearing and which is covered after washing and lubricating with engine oil, must not be defective when rotating.

Cracks or other defects make it necessary to replace the bearing. This bearing must be checked after it has been loaded with a force of 50...100 N. When checking the upper and lower control arms (12, 30, fig. 3.6), make sure that they are not deformed or cracked. Replace the control arms if special threads are damaged or cracked. If necessary, the lower control arms can be straightened and checked with a defect servo.

Replace the control arm's threaded pins and threaded bushings with new pins that are broken, damaged or excessively worn. Also replace the adjusting pin (34, fig. 4.6) with a worn M18x2,5 thread or a wrench socket (S = $6^{+0.2}_{+0.1}$ mm) in the lower control arm pin (32) with a worn or damaged M18x2,5 thread and an internal thread for the grease nipple. The lubricating holes of the pin should be unobstructed and should be pushed through and cleaned if they are clogged with aged

hard grease. Front suspension springs cannot be repaired. Replace them if they are worn or damaged.

Repair of the stabilizer (Fig. 4.10) consists in replacing worn or damaged rubber cushions (8.11) and swivel rod sleeves on the frame and checking the technical condition of the connectors (10), in particular their straightness and the quality of their threads on the connectors.

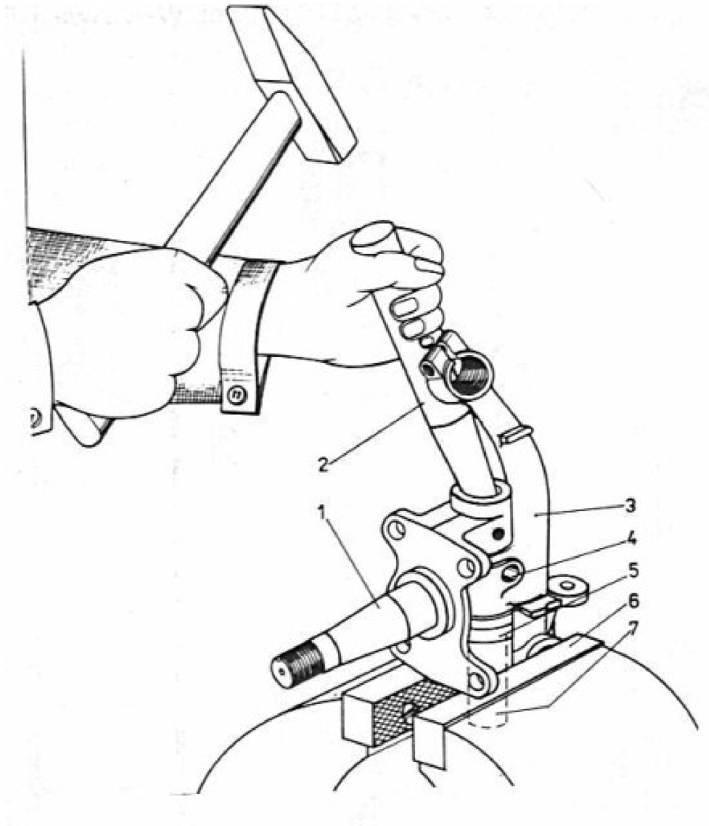
Replace all damaged grease nipples and, if reused, check for leaks and tightness by testing the grease. Stabilizer couplings with damaged threads or cracks must be replaced.

Check that the stabiliser bar (6) is in the correct shape, has not been injured or bent. The deformed stabiliser may be straightened by press or other means. The stabilizer bar on the marking plate should not be more than 6 mm apart. When repairing the front suspension and stabiliser, all sheet metal pressed parts are also inspected. In case of deformation, they can be straightened, and in case of small cracks, they can be welded and painted (applies only to spring sockets, brackets, brackets, etc.).

Replace rubber bumpers if they are permanently deformed or cracked.

Carefully check the front suspension bar for deformation or cracking. All cracks can be electrically welded. Avoid overheating of welded areas. The joints should be applied along the beam. Weakened areas can be reinforced by the use of reinforcement strips. Minor deformations, which do not affect the operation of the suspension, can be left, while larger deformations of the beam must be straightened (on the press), because in this condition it will not be possible to set the wheels and the steering wheel properly. Check the condition of the M10 threaded holes for the attachment of the intermediate lever brackets for the steering rods.

4.2.3 Repair of front suspension



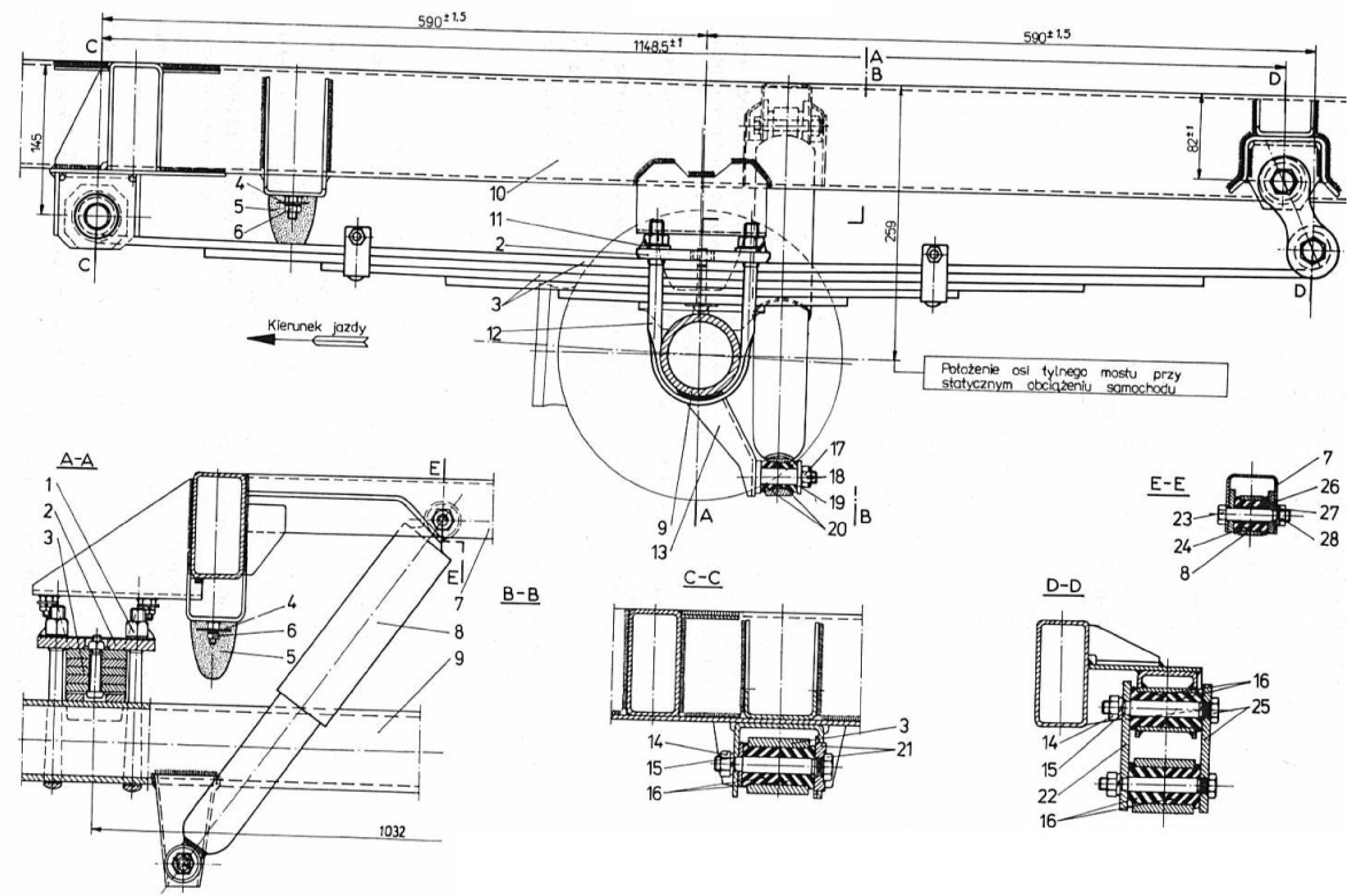
1 - crossover, 2 - drift (17-3001-N), 3 - control arm connector. 4 - wedge hole for the steering kingpin. 5 - thrust bearing, 6 - workshop vice, 7 - switch pin

1 - zwrotnica, 2 - wybijak (17-3001-N), 3 - łącznik wahaczy. 4 - otwór na klin sworznia zwrotnicy. 5 - łożysko oporowe, 6-imadło warsztatowe, 7 - sworzeń zwrotnicy

4.17. Figure: KNOCKOUT OF THE STEERING KINGPIN (WYBIJANIE SWORZNIA ZWROTNICY)

All front suspension screws and nuts of concern should be replaced with new ones, in particular lower control arm axle fixing screws, spring seats, suspension arm connector clamping screws, wheel nuts and bolts, as they are critical for safe driving. When mounting and adjusting the front suspension, e.g. after repair, the nuts and bolts of the threaded connections should be tightened evenly, observing the torque values given in Table 8-2.

4.3 REAR SUSPENSION



4.18. Figure: REAR SUSPENSION

1 - nut, 2 - spring cap, 3 - spring, 4 - spring washer (Z 8.2), 5 - bumper, 6 - nut M8, 7 - cross-bar of frame 8 - shock absorber, 9 - rear, most 。 10 - car frame, 11 - protective washer, 12 - spring stirrup, 13 - shock absorber, 14 - nut, 15 - spring washer, 16 - rubber sleeve. 17 - crown nut, 18 - pin. 19 - washer, 20 - elastic sleeve, 21 - spring pin, 22 - hanger plate, 23 - bolt, 24 - rubber sleeve. 25 - spring bracket, 26 - metal sleeve, 27 - washer, 29 - nut
Dimensions 590 ± 1.5 - applies to the spring in its straight state

1 - nakretka, 2 - nakładka resoru, 3 - resor, 4 - podkładka sprezysta (Z 8.2), 5 - zderzak, 6 - nakretka M8, 7- poprzeczka ramy 8 - amortyzator, 9 - tylny most 。 10 - rama samochodu, 11 - podkładka zabezpieczajaca, 12 - strzemie resoru, 13 - wSpornik mocowania amortyzatora, 14 - nakretka, 15 - podkładka sprezysta, 16 - tulejka gumowa. 17 - nakretka koronowa, 18 - zawleczka. 19 - podkładka, 20 - tuleja elastycznia, 21 - sworzen resoru, 22 - plytka wieszaka, 23 - sruba, 24 - tuleja gumowa. 25 - wieszak resoru, 26 - tuleja metalowa, 27 - podkładka, 29 - nakretka Wymiary 590 ± 1,5 - dotyczą resoru w stanie prostym

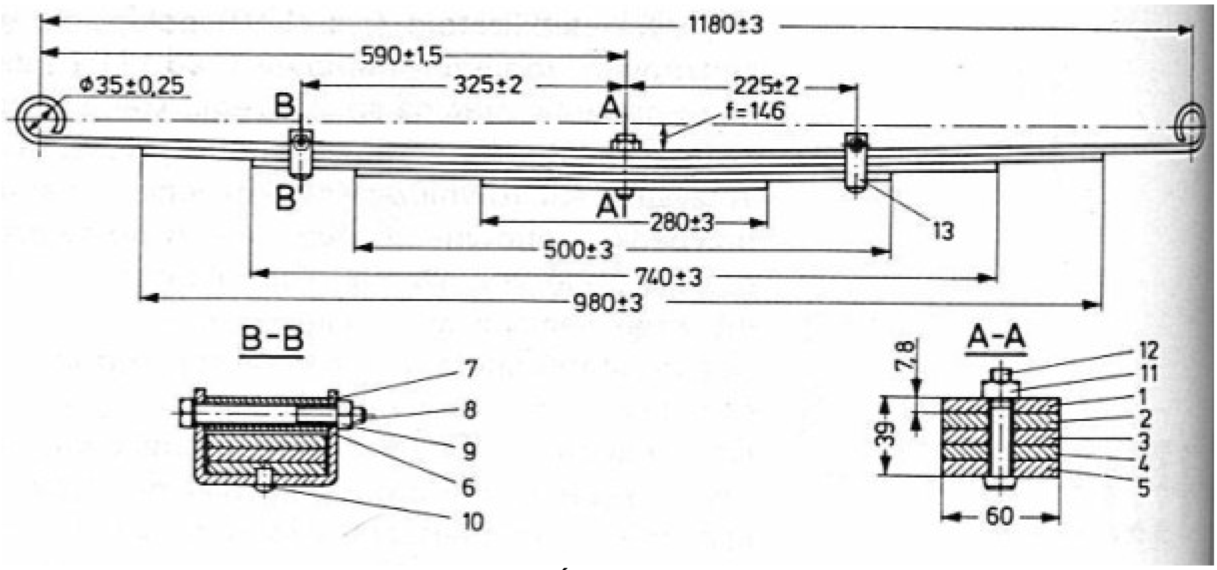
4.3 REAR SUSPENSION

The rear bridge is suspended (depending on) the two longitudinal semi-elliptical five-chamber springs (3, Fig. 4.18). The vibrations of the rear suspension, wheels and body are absorbed by the hydraulic double acting telescopic shock absorbers (8). The springs are connected to the vehicle frame (10) with pendulum hangers (25), fixed brackets with rubber bushings (16) and pins (21), and with the rear axle with four stirrups (12).

Four rubber bumpers (bumpers) are screwed to the car frame to limit the travel and to prevent the rear axle from hitting the frame while driving (5). Two of them are bolted over the rear bridge and the other two over the springs.

The buffers screwed to the frame over the springs act as elastic elements, cooperating progressively with the springs.

4.3.1 Leaf spring



1, 2, 3, 4, 5 - spring feathers, 6 - cap sleeve, 7 - cap of the third pen. 8 - screw (M8X90), 9 - nut, 10 - rivet (010-18). 11 - nut (M10x1,25), 12 - pen pull screw, 13 - pen cap.

1, 2, 3, 4, 5 - pióra resoru, 6 - tulejka skuwki, 7 - skuwka pióra trzeciego. 8 - śruba (M8X90), 9 - nakrętka, 10 - nit (010-18). 11 - nakrętka (M10x1,25), 12 - śruba ściągająca pióra, 13 - skuwka pióra

4.19. Figure: LEAF SPRING (RESORY PIÓROWE)

The rear suspension springs (Figure 4.19) shall consist of five 7,8 mm thick and 60 mm wide feathers.

The springs, made of 60S2A spring steel, are hardened and tempered to a hardness of 388...477 HB.

The characteristics of the spring are given in Table 4-7, and the bending radii of the spring feathers in Table 4-8.

The spring feathers are connected with the central screw (12) and the two caps (13) bolted together. The nut of the spring pen tightening screw shall be secured against loosening by unscrewing the screw end (after tightening the nut to 43 ± 1 N-m).

The spring feathers are shot peened with a fine steel shot to increase their fatigue strength.

All working surfaces of the feathers are lubricated with graphite grease when the springs are folded down. The spring rubber buffers (5, Fig. 4.18) are made of hard rubber with a steel insert used to screw them to the car frame.

4.3.1 Leaf spring

Rubber bushings in the eyes of the springs and shock absorbers absorb the additional vibration of the rear suspension. The fatigue life of the spring tested on the stenosis is approximately 120 000 cycles at a maximum load of 760 daN and an amplitude of 97 mm.

Load condition	**Value of load, daN**	**Deflection arrow mm**	**Deflection from position at initial load, mm**	**Flexibility mm/100, daN**
Initial load (flexibility tests)	300	89 ± 4,8	-	-
Nominal load	630	-	62,7 ± 4,8	19 ± 14
Final load (flexibility tests)	700	-	76 ± 5,5	-
Maximum load	760	-	-	-
Catalog reference number	19-2912010			
Weight	14,2 kg			

4.7. Table: LEAF SPRINGS CHARACTERISTICS

Leaf number	**Inner radius, mm**
1	1350
2	1200
3	1150
4	1150
5	1180

4.8. Table: INTERNAL BENDING RADII OF THE LEAF SPRING

The springs are fixed to the rear bridge casing by means of stirrups (12, fig. 4.18) and nuts (1). These nuts are secured with bent washers (covering the two ends of the stirrup). The springs are fixed to the frame by means of steel pins (21, 25) with a diameter of $16_{-0.12}$ mm, fitted with rubber bushings (16), pressed into the spring eyes. The pins are cyanated and tempered to a hardness (surface) of at least 50 HRC.

The rear spring eyes are attached to the frame on pendulum hangers. The spring hook consists of a steel plate (8 mm thick) into which the two hook pins (25) are pressed. It is mounted in rubber bushings (16), pressed into the spring eyes and the bracket is welded to the frame. The hanger is screwed with two M10x1,5 nuts.

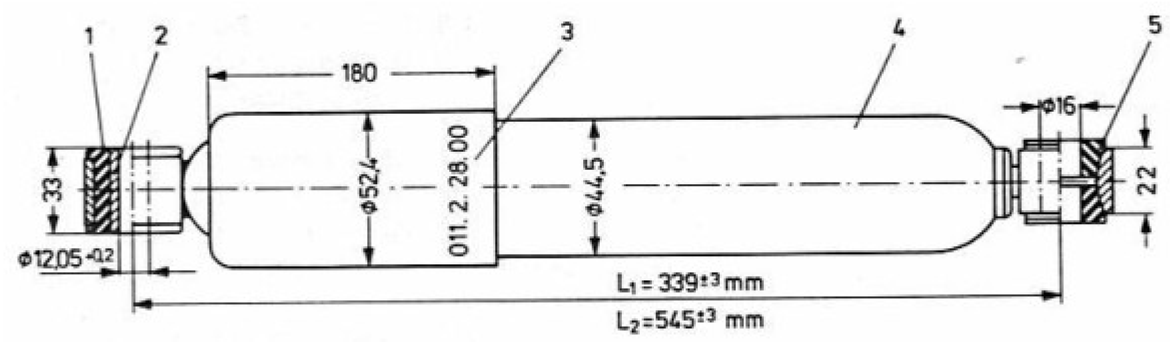
After the rear bridge, springs and shock absorbers have been fitted to the vehicle, the nut of the spring bolts and hangers is finally tightened under the static load of the vehicle within 30...40% of its full load capacity. The rubber bushings (16) used, which transmit the torsional moments, are mounted with a significant pressure. The dimensions of the springs are shown in Fig. 4.19.

When mounting the rear suspension to your vehicle, please follow the instructions:

- rinse the spring eyes and pins with petrol before fitting,
- tighten the spring stirrup nuts and crown nuts of the shock absorber mountings to 60 N·m when the spring straightening car is loaded,
- lubricate the threads of the fasteners before screwing with STP grease.

4.3.2 Rear shock absorber

The rear shock absorbers (Figure 4.20) have a larger diameter and stroke of the piston and a different method of attachment to the frame and rear axle than the front shock absorbers. The upper shock-absorber eyes are attached to the frame crossbar and the lower eyes are attached to the pivots of the rear bridge supports (13, fig. 4.18). In order to increase their stroke and better dampen vibrations, they are inclined at the top to the longitudinal axis of the car.



4.20. Figure: REAR SHOCK ABSORBER (AMORTYZATOR TYLNE)

1 - rubber bushing for the upper ear. 2- upper ear sleeve, 3 - metal sleeve, 4 - shock absorber, 5 - lower ear rubber sleeve, L_1 - length of the shock absorber in the compressed state, L_2 - length of shock absorber in extended condition

1 - tuleja gumowa ucha górnego. 2- tuleja ucha górnego, 3 - osłona metalowa, 4 - amortyzator, 5 - tuleja gumowa ucha dolnego, L_1 - długość amortyzatora w stanie Ściśniętym, L_2 - długość amortyzatora w stanie rozciągniętym

Typ	28, hydraulic double acting telescopic
Amount of oil in the shock absorber *	220 + 10 cm^3
Oil grade	AT oil according to BN-72/0535-28
Control characteristics of the shock absorber:	
- stroke of the device	101,6 mm
- frequency of appliance	1,733 Hz 0,15 Hz
- reflecting force (P_o)	182 ± 23 daN 27 daN
- deflective force (P_u)	96 ± 12 daN 18 daN
Test temperature	20 ± 5 °C
Shock absorber weight	2,09 kg
Durability of shock absorbers	750 000 duty cycles
Requirements and tests according to	BN-77/3612-09
Order number	011.2.28.00
Manufacturer	F.A. Krosno

* The oil in the shock absorbers is not replenished or replaced during the entire life of the vehicle.

4.9. Table: CHARACTERISTICS OF REAR SHOCK ABSORBERS

The characteristics of the rear shock absorbers are given in Table 4-9. A rubber metal sleeve is pressed into the upper ear of the shock absorber (1 and 2, Fig. 4.20) and two rubber sleeves are pressed into the lower ear (5). The piston rod of the shock absorber is connected at the top with a metal cover (3), which protects the shock absorber from penetration of dirt into the shock absorber.

4.3.2 Rear shock absorber

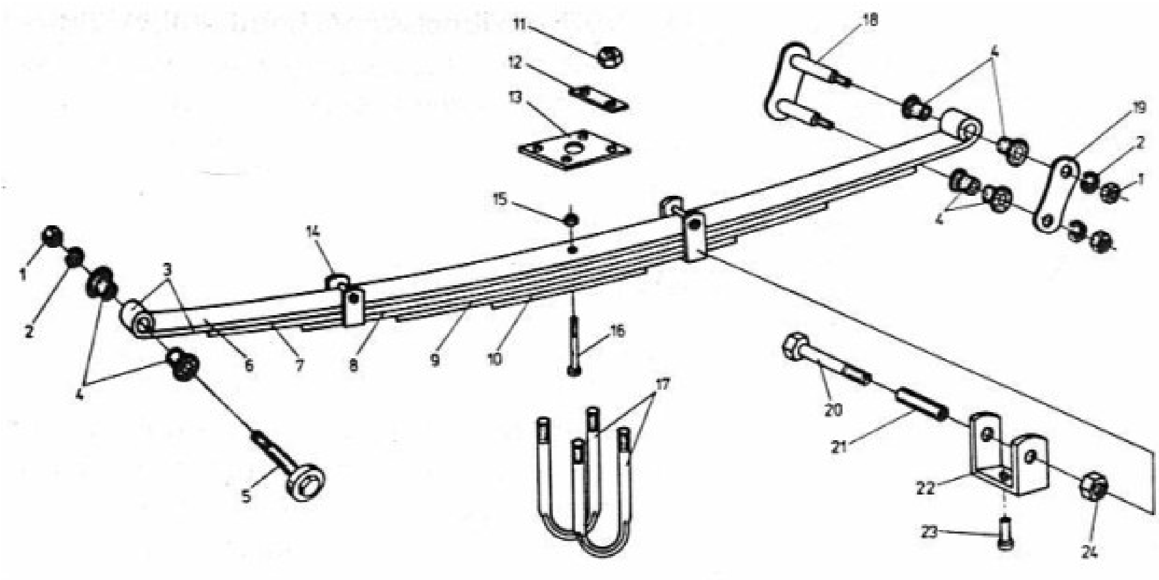
The double acting shock-absorbers are designed to exert a greater damping force during the stroke of the rebound than during deflection (40...50%).

4.3.3 Repair of rear suspension

For more serious repairs to the rear suspension, remove the rear axle, springs, and shock absorbers from the vehicle. Minor repairs to the suspension shall be carried out in the vehicle. First of all, the rubber bushings of the springs and shock absorbers, which are subject to wear and tear or damage, must be checked carefully.

Trouble	Reasons	Method of repair
1. Rear suspension noise and knocks.	1.1 Fracture pen in spring or worn spring.	1.1 Replace the damaged pen or spring.
	1.2. Damaged or worn spring rubber bushings.	1.2 Replace damaged or worn parts.
	1.3. Damaged or loose spring stirrup.	1.3 Replace damaged stirrups and tighten with a suitable torque if loose.
	1.4 Breaked spring cap.	1.4 Insert a new cap.
	1.5 Unbalanced rear wheels.	1.5 Balance the wheels in the ASO.
	1.6. faulty shock absorbers.	1.6 Replace the shock absorbers.
	1.7 Damaged or worn rubber buffers on the frame.	1.7 Replace the rubber bumpers.
2. Car tilted to one side or pulled sideways while travelling straight ahead	2.1 Incorrect pressure in one wheel.	2.1 Inflate the air to the required value.
	2.2 Fracture of spring or loose spring stirrup.	2.2 Check the stirrup nuts for broken spring blades.
	2.3 Defective shock absorber.	2.3 Replace the shock absorber.
	2.4. incorrectly adjusted brake on one wheel (locks).	2.4 Adjust the brake.
	2.5 Unsymmetrically loaded vehicle.	2.5 Distribute the load correctly on the carrier.

4.10. Table: REAR SUSPENSION TROUBLESHOOTING



4.21. Figure: REAR SPRING AND HANDLES (RESOR TYLNY I UCHWYTY)

1- nut (M14x1,5), 2 - spring washer, 3 - springs ppl. 4- rubber bushing, 5 - spring pin, 6 - spring pin I (main), 7 - spring pen, 8 - spring Ill pen, 9 - spring IV pen, 10 - spring V pen, 11 - nut, 12 - spring washer, 13 - spring cap, 14 - spring cap III, 15 - nut M10x1, 25. 16 - turnbuckle, 17 - spring stirrup, 18 - spring hook, 19 - hook plate, 20 - screw (M8x85). 21 - distance sleeve, 22 - pen tip IV, 23 - rivet. 24 - nut M8

1- nakrętka (M14x1,5), 2 - podkładka sprężysta, 3 - resor kpl. 4- tulejka gumowa, 5 - sworzeń resoru, 6 - pióro I resoru (główne) 7 - pióro Il resoru, 8 - pióro Ill resoru, 9 - pióro IV resoru, 10 - pióro V resoru, 11 - nakrętka, 12 - podkładka zabezpieczająca, 13 - nakladka resoru, 14 - skuwka pióra III, 15 - nakrętka M10x1, 25. 16 - śruba ściągająca, 17 - strzemię resoru, 18 - wieszak resoru, 19 - płytka wieszaka, 20 - śruba (M8x85). 21 - tulejka odległościowa, 22 - skuwka pióra IV, 23- nit. 24 - nakrętka M8

4.3.3 Repair of rear suspension

Replace any damaged or excessively worn parts. If necessary, the spring itself (fig. 4.21) or the shock absorber can be removed from the suspension. To remove springs or shock absorbers from the vehicle, lift the rear of the vehicle with a jack or other device so that the wheels do not touch the ground and slide the stands (trestles) under the stringers of the frame. Then lift the rear bridge and secure it against falling down when dismantling. After removing and cleaning the springs, check their condition and characteristics (Table 4.7). If the deflection force is too low, it indicates permanent deformation of the feathers and the entire spring.

The proper characteristics of the spring can be restored by changing the deformed leaves, or (alternatively) by bringing them to the required shape with a hammer, after heating the pen to 50°C. Start from the middle of the pen and continue towards the ends of the pen, with the amount of impact you will feel gradually reduced as you approach the ends of the pen. Replace cracked, excessively worn or corroded leaves.

Before assembling the spring, all the leaves should be cleaned with a wire brush, washed with kerosene and generously lubricated with graphite grease. When using your vehicle intensively, it is recommended that you do this every 12 months.

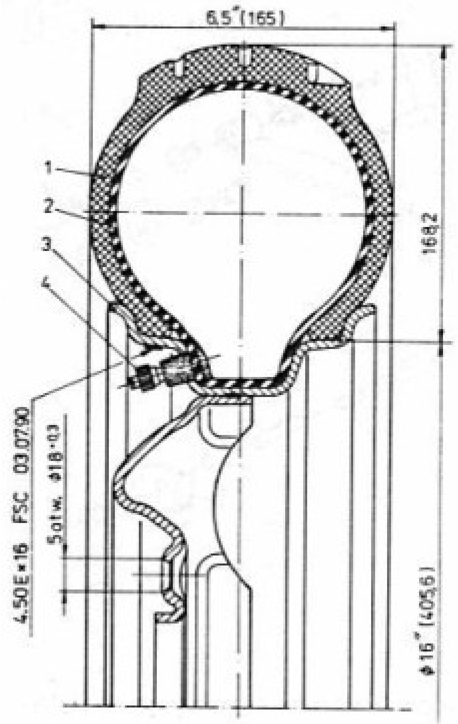
■ The spring pins (Fig. 4.21) wear out quite quickly due to the severe operating conditions in the rubber bushings (without lubrication, they are exposed to dirt and sand). The nominal diameter of the pin is $16_{-0.12}$ mm; if the wear exceeds the limit of Ø 15.4 mm, the pin must be replaced.

The spring rubber buffers shall not be damaged and shall have adequate elasticity. They must be replaced if the rubber is worn out, cracked or deformed.

Replace spring clips and fasteners in the event of corrosion or damage to the thread. If the shock absorbers do not operate properly, check their characteristics (Table 4-9) on a special test rig at the service station as described for the front shock absorbers (see Chap. 4.2.3). The proper operation of shock absorbers depends on the vehicle's behaviour in service and the durability of other assemblies, which is why using a vehicle with malfunctioning shock absorbers is very harmful.

After the suspension has been repaired and installed, check its operation during the test drive of the vehicle; pay attention to the operating noise of the suspension (knocks, squeaks) and the correct damping of shocks. If the suspension is not working properly, check the suspension and correct the malfunctions.

4.4 ROAD WHEELS



1 - Tyre.
2 - inner tube,
3 - wheel rim,
4 - inner tube valve 4.50E x 16 x FSC x 03.07.90 - wheel characteristic

1 - opona.
2 - dętka,
3 - obręcz koła,
4 - zawór dętki 4.50E x 16 x FSC x 03.07.90 - cecha koła

4.22. Figure: ROAD WHEEL

4.4.1 Wheels

Single wheels with inner tubes and radial or diagonal (Fig. 4.22) tyres are used in the Żuk car.

The running wheel consists of a rim and a disc. The rim is made of steel strip (grade 08J) with dimensions 195x3,7 mm. It is rolled up to a diameter of 405,6 mm, electrically bonded, profiled and calibrated. The wheel centre is pressed from a 3,5 mm thick carbon steel sheet (15X). After extrusion of the disc, holes are made for wheel fixing screws. The disc shall then be pressed into a 347,6 ± 0,2 mm diameter rim hole with a press of 0,3...0,5 mm.

In this condition, the radial and axial runout of the wheel is checked and the disc is electrically welded at 12 points with a minimum diameter of 12 mm, or welded at 8 points with fillet welds of 3 x 45 mm.

Four 6x90 mm oval holes are provided around the wheel centre to ventilate and cool the brake drums while the vehicle is moving. A hole Ø 15,7+0,4 mm is made in the wheel rim to accommodate the inner tube valve. The axial and radial runout of the wheel shall not exceed 1,2 mm. Each wheel (3, Fig. 4.22) has a stamped feature indicating the dimensions, manufacturer's mark and year, month and day of manufacture (e.g. 4.50E x 16 FSC 03.07.90). The wheels are primed with one layer of carbamide II phthalic primer according to BN-80/6113-04 and sprayed with styrene phthalic enamel 3361-701-XXX in body colour.

4.4.2 Tyres

The tyres shall be tubed with radial or diagonal (bias-ply) tyres, as identified in Tables 4 to 10.

Diagonal (bias-ply) tyres are only used for cars on the domestic market.

Tyre designation 6.50 R16 C10 PRD-1001:

- 6.50" (165 mm) - tyre width,

4.4.2 Tyres

- R - radial tyre,
- 16" (405,6 mm) - diameter of the rim fit,
- C- Tyre for light commercial vehicles and minibuses,
- 10PR - number of layers of the matrix (permissible load capacity),
- D - 100 - Road tread pattern,
- I - first grade tyres,
- Nylon/Steel - carcass and belt material

The tyre is constructed of a carcass consisting of a layer of polyamide cord with a thick layer of viscose canvas (cord) backing, a rubberised tread, a sculpture improving the tyre's adhesion to the road surface, and then a bead reinforced with steel wire rings, immediately adjacent to the wheel rim when fitted. There are inscriptions (tyre markings) and centering drawings on the side of the tread.

Type of wheel	single
Diameter	4.50E x 16
Radial or diagonal (bias-ply) tyres *	6.50R16C 10PRD-1001 / 6.50-16C6 PRK-51
Tyre tubes	6.50-16 (Butyl)
Tyre pressure	
- front wheels	0,25 MPa
- rear wheels	0,32 MPa
Part number of wheel	17 – 3101010
Tyre load capacity:	
- front wheels	5,9 kN
- rear wheels	7,25 kN
Durability of tyres	40 000 km
Requirements and tests	in accordance with PN-88/C-94300.041

* For cars on the domestic market.

4.11. Table: RUNNING WHEELS TECHNICAL DATA (DANE TECHNICZNE KÓŁ JEZDNYCH)

Radial tyres have low rolling resistance, which is associated with fuel savings (about 5%), are characterized by a longer service life (about 50%), load-bearing capacity (about 10%), better adherence to the road surface. Radial tyres, however, are more expensive (around 40%) than diagonal tyres. Durability refers only to tyres that have been used correctly for up to three years from their date of manufacture.

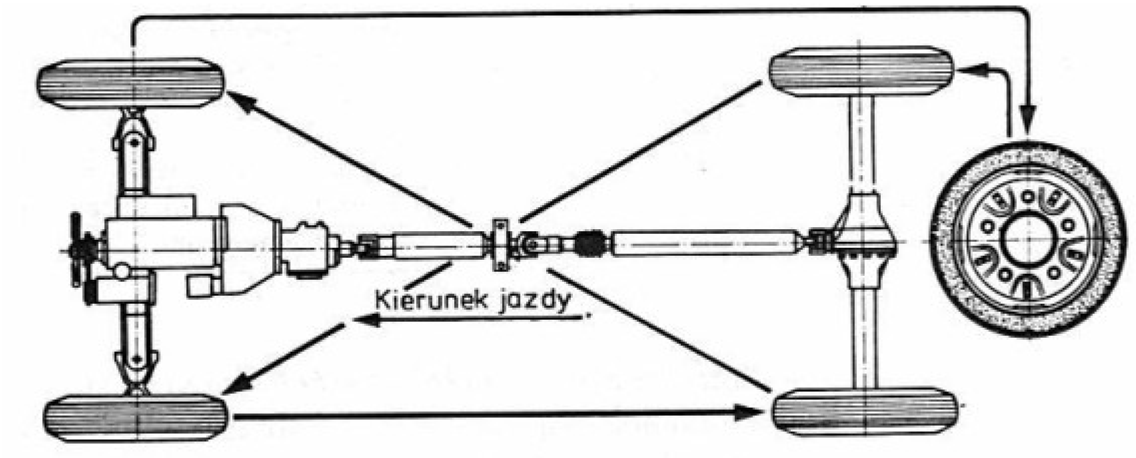
The construction of valve tubes is well known and does not require a separate description.

4.4.3 Repair of wheels and tyres

The malfunctions of the wheels and tyres, their causes and the methods of repair are given in Table 4-12. The service life of the tyres depends largely on their correct and accurate handling. Before each journey, the tyre pressure should be checked and, in the event of a loss, topped up to the required value. During OT-II maintenance (every 9000 km), the wheels in the vehicle shall be replaced as shown in Figure 4.23. This shall ensure uniform wear of all tyres.

4.4.3 Repair of wheels and tyres

Check the wheel rims for deformation, dents, cracks or damaged conical holes for the fixing nuts. Fine deformations of the rim may be rectified and the lateral and radial runout of the wheel shall be checked (not more than 1,2 mm). Wheels that do not meet these requirements cannot be used for a car because they cannot be balanced. Alternatively, the wheel can be used as a spare wheel. The wheel in which the bevel holes Ø 18+0,3 (for the fixing nuts) are damaged or aligned cannot be used even on the spare wheel.



4.23. Figure: ORDER OF REPLACEMENT OF THE WHEELS IN THE CAR (EVERY 9000 KM)

Tyres produced three years ago should not be fitted to the car due to the aging of the rubber (even if it has been stored correctly). A tyre that has a damaged carcass or broken wire in its bead must not be fitted to a vehicle.

Small cracks on the outer surface of a tyre (especially on the periphery, on the sidewalls) indicate a severe ageing process or damage to the tyre as a result of driving at too low a pressure or with an overloaded vehicle.

Tyres with a tread height of less than 1,6 mm (without other damage) shall be either retreaded or replaced. Tyres may only be retreaded once (tyre regeneration according to BN-75/6615-06).

Balance the volcanised tyre wheel at the service station.

Damaged tubes should be repaired by applying hot patches. Replace damaged inner tubes. When fitting tyres on wheels, it is advisable to use inner tyres and sprinkle talcum powder on the inner tube surface, making sure that the inner tube is not twisted in the tyre.

A torque wrench shall be used to tighten the wheel fixing nuts on the mounting strap and in the repair shop to the torque specified in Table 8-2. In driving conditions, the wheels shall be tightened firmly using the wrench provided in the driver's tool kit.

4.4.3 Repair of wheels and tyres

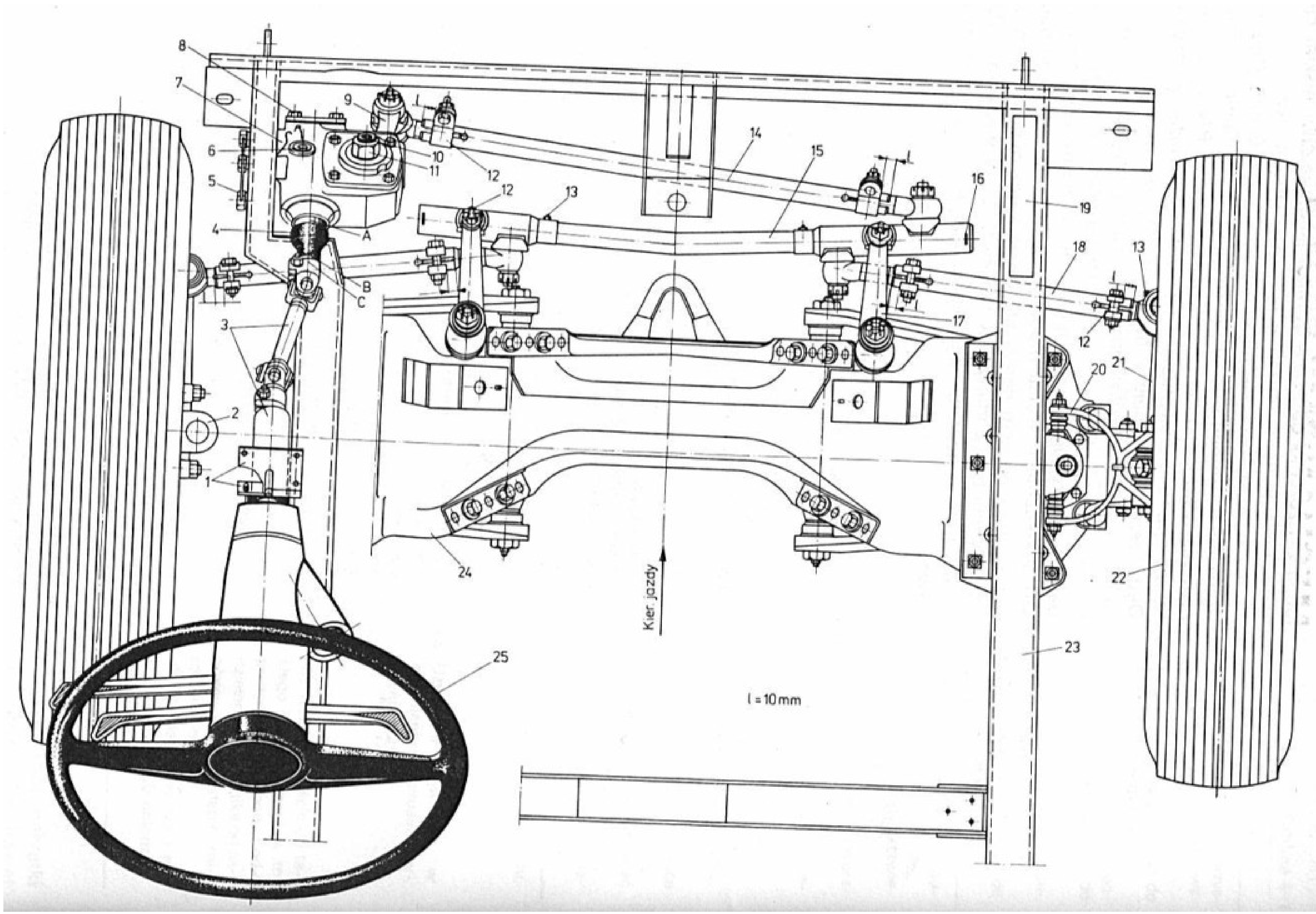
Trouble	Reasons	Method of repair
1. Excessive tyre wear	1.1 Too rapid a change in driving speed and severe braking.	1.1 Avoid excessive acceleration and braking.
	1.2 Excessive speed in difficult terrain.	1.2 Adjust the speed to the condition of the road surface.
	1.3 Excessive speed with tyre pressure too low.	1.3 Check the pressure and, if necessary, inflate to the required value.
	1.4 Overloading of the vehicle.	1.4 Do not exceed the permissible load.
	1.5 Tyre pressure too high or too low.	1.5 Adjust the pressure to the required value.
2. Uneven tyre wear	2.1. front wheel alignment too small or too large.	2.1 Check and adjust the alignment of the wheels,
	2.2 Incorrect wheel angles.	2.2 Adjust the angles of the wheels on the ASO,
	2.3 Different air pressures on the wheels of the same axle.	2.3 Align the pressure to the correct value,
	2.4 Excessive speed in bends.	2.4 Limit speed on sharp bends.
	2.5 Damaged shock absorber.	2.5 Replace the shock absorber.
	2.6 Unbalanced wheels.	2.6 Balance the wheels in the ASO.
	2.7 Excessive play in wheel bearings.	2.7 Adjust the bearing play.
	2.8 Uneven braking of the wheels	2.8 Adjust the brakes on all wheels.
	2.9. Curved wheel rim	2.9. Replace or straighten the rim and balance the wheel.
	2.10. Tyres incorrectly mounted on rims.	2.10. Fix tyre fitting
3. Tyre damaged	3.1 Breakage of the cord thread along the edge of the tread due to overloading of the car.	3.1 Do not overload the vehicle.
	3.2 Too low a pressure in the corner of the tyre to break the carcass of the tyre, especially when hitting sharp obstacles (e.g. kerbstone).	3.2 Replenish the tyre with fresh air if necessary.
	3.3 Long lasting overspeed at low pressure or overload.	3.3. this condition must be avoided; it may cause the tyre to overheat, dislodge the tread from the carcass and cause damage to the tyre.
	3.4 Riding on an unbearable surface with anti-slip chains.	3.4 Use chains only on snowy or icy roads.

4.12. Table: TYRES TROUBLESHOOTING

5 GUIDANCE SYSTEMS

Guidance mechanisms enable the driver to control the direction of travel and to stop the vehicle at the required location. These include the steering and braking systems.

5.1 STEERING



1 - shaft fixing bracket, 2 - left steering knuckle, 3 - steering shaft, 4 - rubber shaft cover, 5 - washer fixing screws, 6 - shaft filler, 7 - steering gear, 8 - lid fixing screws, 9 - gearbox lever, 10 - adjustment spindle. 11 - safety nut, 12 - clamping bracket, 13 - rod grease nipple, 14 - intermediate management groove, 15 - central management rod, 16 - pin, 17 - right intermediate lever, 18 - external management groove, 19 - chassis number, 20 - upper control arm, 21 - crossover lever right, 22 - chassis wheel, 23 - car frame, 24 - front suspension beam, 25 - steering wheel A, B, C - setting marks on the gearbox roller and steering shaft, L=10 mm - distance of the bracket from the front of the steering dracks.

1 - jarzmo mocowania wału, 2 - zwrotnica lewa, 3 - wał kierownicy, 4 - osłona gumowa wałka, 5 - śruby mocowania podkładki, 6-korek wlewu okleju, 7 - przekładnia kierownicza, 8 - śruby mocowania pokrywy, 9 - dźwignia przekładni, 10 - trzpień regulacji. 11 - nakrętka zabezpieczająca, 12 - obejma zaciskowa, 13 - smarowniczka drążków, 14 - drazek kierowniczy pośredni, 15 - drążek kierowniczy Środkowy, 16 - zawleczka, 17 - dźwignia pośrednia prawa, 18 - drazek kierowniczy zewnętrzny, 19 - numer podwozia, 20 - wahacz górny, 21 - dźwignia zwrotnicy prawa, 22 - koło jezdne, 23 - rama samochodu, 24 - belka przedniego zawieszenia, 25 - koło kierownicy A, B, C - znaki ustawcze na walku przekładni i wale kierowniczym, L=10 mm - odległość obejmy od czoła drazków kierowniczych.

5.1. Figure: STEERING

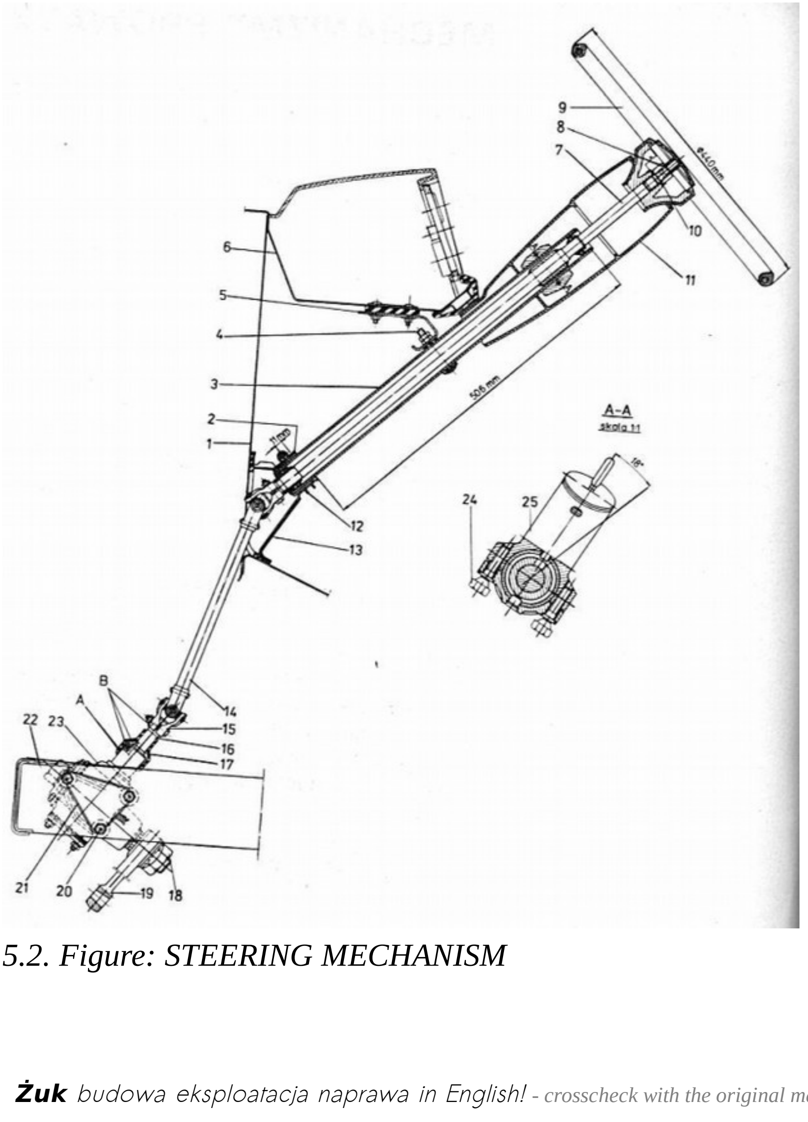
5.1 STEERING

The steering system used in Żuk cars has an unassisted worm drive. It consists of two distinct but functionally interconnected mechanisms (Figure 5.1): steering rods and steering knuckles. The steering mechanism transmits the rotational movement of the steering wheel to the steering mechanism directly connected to the front wheels of the vehicle.

Gearbox type	worm drive / with globoidal screw and double roller
Average position of the steering mechanism	18,2 : 1
Steering shaft	articulated
Gear adjustment	by turning the adjusting pin on the side of the side cover
Oil quantity and type in the steering transmission	0,33 dm^3, Hipol 15
Number of plugs in the housing	one (filler and inspection)
Outer diameter of steering wheel	Ø 440 mm
Steering rod system	symmetrical with intermediate levers with intermediate rod
How to connect the rods	ball joints (demountable)
Adjusting the wheel alignment	by turning the pipes of the outer steering rods and thus changing their active distance
Force needed to rotate the steering wheel while driving	35 N
Steering wheel idle from gearbox centre position	40 mm (10") at steering wheel circumference
Steering wheel rev. speed from left to right extreme wheel position	3,5 of turnover
Steering transmission weight	7,5 kg
Steering transmission order number	14,6-60.808.0
Order number of the steering shaft	14,6-41.803.1
Requirements and tests	in accordance to BN-78/3612-06

5.1. Table: STEERING CHARACTERISTICS

5.1.1 Steering mechanism



5.2. Figure: STEERING MECHANISM

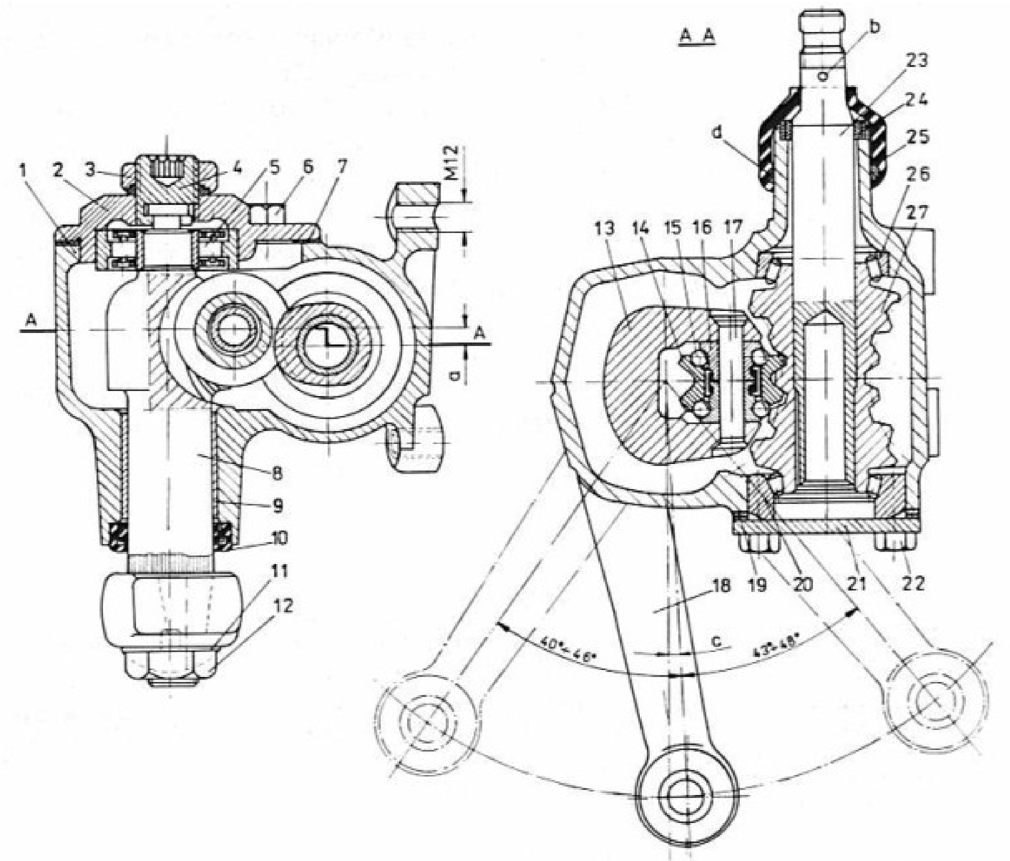
1 - cab front panel, 2 - sleeve, 3 - steering column, 4 - column fixing bracket, 5 - bracket, 6 - dashboard housing. 7 - top roller. 8 - steering wheel fixing nut, 9 - steering wheel fixing nut. 10 - safety pad. 11 - column cover. 12 - column fixing bracket. 13 - joint guard, 14 - intermediate shaft, 15 - forked shaft coupling, 16 - gearbox worm shaft, 17 - rubber guard, 18 - gear nut, 19 - gearbox arm, 20 - gearbox fixing screw, 21 - safety wire. 22 - Vehicle frame. 23 - steering transmission, 24 - special screw, 25 - ignition switch with steering wheel lock, A B - gearbox setting marks in central position

1 - przegroda czołowa kabiny, 2 - tuleja, 3 - kolumna kierownicy, 4 - strzemię mocowania kolumny, 5 - wspornik, 6 - obudowa tablicy rozdzielczej. 7 - wałek górny. 8 - nakrętka mocująca kolo kierownicy, 9 - koło kierownicy. 10 - podkladka zabezpieczająca. 11 - osłona kolumny. 12 - jarzmo mocowania kolumny. 13 - osłona przegubu, 14 - walek pośredni, 15 - załącze rozwidlone wału, 16 - wal ślimakowy przekladni, 17 - oslona gumowa, 18 - nakrętka 19 - ramię przekladni, 20 - Sruba mocow. przekładni, 21 - drut zabezpieczający. 22 - rama samochodu. 23 - przekładnia kierownicza, 24 - śruba specjalna, 25 - wyłącznik zapłonu z blokada kola kierownicy, A B - znaki ustawcze przekładni w położeniu środkowym

5.1.1 Steering mechanism

The steering mechanism (Fig. 5.2) consists of a planetary worm gearbox (23) with an arm (19), a PTO shaft (7, 14, 16), column (3) and a steering wheel (9). The steering gear is attached to the left-hand side of the vehicle frame (22) with three M12 x 50 screws; the steering column with the top shaft (7) is attached at the bottom to the cab front panel (1) with the shield (13) and the bracket (12), at the top with the stirrup (4), via the column support (5), to the dashboard shelf (6). The ignition switch (25) and the combined headlamp switch, covered by a two-piece plastic hood (11), are mounted on the steering column.

■ The steering transmission (Fig. 5.3) consists of a housing (1), cast in malleable cast iron, in which a shaft with a global worm gear is mounted on two tapered roller bearings (27). In a plane perpendicular to the shaft, it is seated at one end in the brass bushing (9) and at the other end in the cylindrical roller bearing (5), the main shaft of the gearbox (8) with a double roller (14), which intermeshes with the worm. The steering arm (18) is mounted on this shaft (on the multi-outlet).



5.3. Figure: STEERING TRANSMISSION (PRZEKŁADNIA KIEROWNICZA)

1 - housing, 2 - side cover, 3 - safety nut, 4 - adjustment pin. 5 - cylindrical roller bearing, 6 - cover screw, 7 - side cover gasket. 8 - main shaft. 9 - Shaft sleeve, 10 - Shaft seal, 11 - Bend washer, 12 - Nut (M22x1,5). 13 - main shaft, 14 - roller, 15 - roller bearing, 16 - bearing sleeve, 17 - roller axis, 18 - transmission arm, 19 - adjustment washers, 20 - outer bearing. 21 for the pressure plate, 22 for the cover screw, 23 for the worm shaft. 24 - felt sealant. 25 - rubber cover, 26 - inner bearing, 27 - worm a=6.2 mm, b= setting mark, c=1956. d= grease-filled channel

1 - obudowa, 2 - pokrywa boczna, 3-nakrętka zabezpieczająca, 4 - trzpień regulacyjny. 5 - łożysko walcowe, 6 - śruba pokrywy, 7 - uszczelka pokrywy bocznej. 8 - wał główny. 9 - tuleja wałka, 10 - uszczelniacz wałka, 11 - podkładka odginana, 12 - nakrętka (M22x1,5). 13 - wał główny, 14 - rolka, 15 - łożysko rolki, 16 - tuleja łożyska, 17 - oś rolki, 18 - ramię przekładni, 19 - podkładki regulacyjne, 20 - łożysko zewnętrzne. 21 - płytka dociskowa, 22 - śruba pokrywy, 23 - wałek ślimaka. 24 - uszczelniacz filcowy. 25 - osłona gumowa, 26 - łożysko wewnętrzne, 27 - ślimak a=6,2 mm, b=znak ustawczy, c=1956. d=kanałek wypełniony smarem

The roller's axis of rotation is not perpendicular to the axis of rotation of the main shaft, the deflection (7°15') ensures a large area of contact between the roller and the worm; in addition, it is shifted about the worm's axis by 6.2 mm. The clearance between the teeth of the roller and the worm is therefore variable (the smallest is in the middle position). Thanks to such a design, it is possible to adjust the gear clearance between the screw and the roller (as the gearing wears out by axial movement of the adjusting pin (4) of the main shaft (8)).

■ The screw (27, Fig. 5.3), made of alloyed steel, is cyanated to a minimum depth of 0,25 mm and tempered to a hardness of 52... 60... HRC. It has a single coil cut with a diameter of $39{,}24_{-0.025}$ mm.

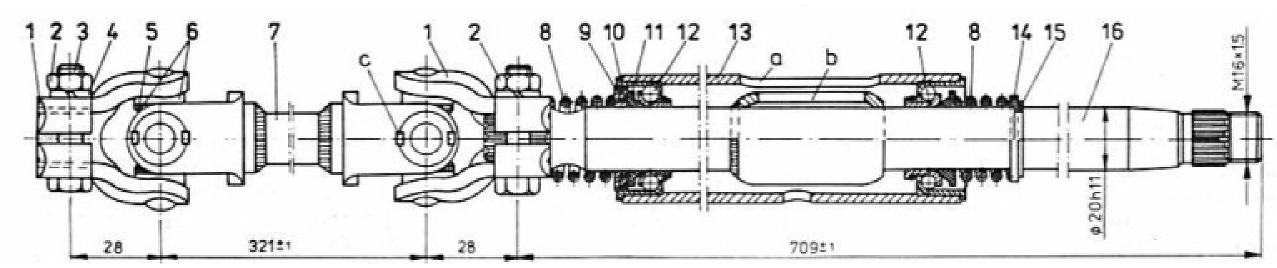
5.1.1 Steering mechanism

The tapered worm pivots are the inner raceways of the bearings and the rings (20.26) are the outer raceways. The hollow shaft (23) is pressed into the multi-screw hole of the worm. The outer ring (20) is slide seated so that the clearance in the worm bearings can be adjusted using a pressure plate (21) and washers (19). The shaft (23), made of a steel rod (023 mm), is sealed in the housing with a felt ring (24) and a rubber shield (25). At the end of the shaft there is mounted (on the multi-outlet) the end of the universal joint of the intermediate shaft, tightened with a screw. The main shaft of the gearbox, forged from alloy steel, is surface-hardened to a depth of 1,5...3.0 mm up to a minimum hardness of 45 HRC; it is ended with a tapered splined shaft and an M22 x 1,5 thread to secure the gearbox arm. The center position of the arm is indicated by signs on the housing and on the shaft (the "b" symbol).

At the top of the main shaft (8), a roller (14) made of alloy steel is fitted. It is carburised to a depth of 0,8...1,3 mm and tempered. The length of the roller with bearing is $31^{+0.120}_{-0.025}$ mm and its outer diameter is 42,945 mm. The roller is fixed on a double ball bearing (11 balls each with a diameter of 6,35 mm). The inner ring raceways are mounted on a steel axis with a nominal diameter of 12 mm, riveted (after induction heating) in the sockets of the main shaft (8).

■ The main shaft is housed in a bronze bushing (9) and a cylindrical roller bearing (5) for axial movement of the shaft. With this bearing, the worm gear play with the roller can be adjusted by turning the adjusting spindle (4). The bearing sleeve is covered with a rubber seal (10).

■ The gearbox arm (18, Fig. 5.3), forged from structural steel, is tempered. A conical hole (diameter Ø 18,1 mm) is made at the end of the arm to accommodate the ball joint of the intermediate rod. The split steering shaft (Fig. 5.4) with two universal joints consists of the upper shafts (16) and the intermediate shafts (7).



5.4. Figure: STEERING SHAFT (WAŁ KIEROWNICY)

1 - multi-groove union, 2 - nut (M8x1,25), 3 - bolt, 4 - pad, 5 - bearing gasket, 6 - bearing cross-brace, 7 - intermediate shaft, 8 - spring, 9 - ring shield, 10 - sealing ring, 11 - pressure ring, 12 - angular contact ball bearing (special), 13 - shaft pipe (column), 14 - thrust washer, 15 - settling ring, 16 - top shaft. a - ignition switch mounting channel, b - steering wheel lock locking channel, c - creasing bearing retaining bracket

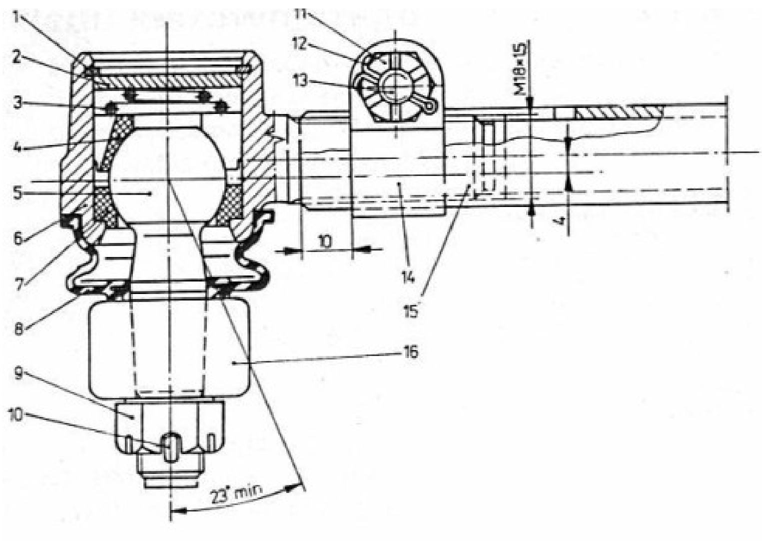
1 - złącze z wielorowkiem, 2 - nakrętka (M8x1,25), 3 - śruba, 4 - podkladka, 5 - uszczelka łożyska, 6 - krzyżak z łożyskiem, 7 - walek pośredni, 8 - sprężyna, 9 - tarcza pierścienia, 10 - pierścień uszczelniający, 11 - pierścień dociskowy, 12 - łożysko kulkowe skośne (specjalne), 13 - rura wału (kolumna), 14 - podkładka oporowa, 15 - pierścień osadczy, 16 - wałek górny. a - kanałek mocowania wyłącznika zapłonu, b - kanałek na rygiel blokady koła kierownicy, c - zagniecenie ustalające łożysko

■ The top shaft (16) is connected to the intermediate shaft by a spline cut in the forks (1) and at the end of the shaft with a screw and a nut (2). It is made of a steel rod with a diameter of 21 mm, covered with a steel tube 0 40 × 2,2 mm, and a shaft tube (column - 13) with a length of 544 mm is mounted on special ball bearings (12). For automatic adjustment of the axial clearance of the shaft,

the inner rings of the lower and upper bearing (12) are pressed against each other by springs (8). On the top shaft (16), a channel sleeve (b) is welded to the steering wheel lock bolt. The ends of the top shaft are cut with fine grooves to fit the steering wheel and the forked end (1) of the universal joint. The intermediate shaft (7, Fig. 5.4) is made of 18 mm steel bar. The forked ends of the universal joints (1), in which the cross-braces mounted in needle roller bearings are mounted, are welded to its ends.

5.1.2 Return mechanism

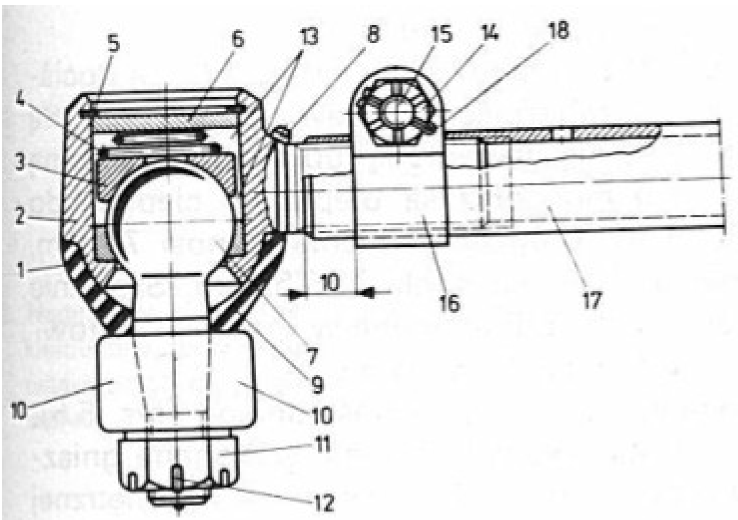
The rotation of the steering wheel causes the swivel arm of the steering gear to swivel out, which transmits its movements to the steering mechanism via an intermediate rod. The steering mechanism (Fig. 5.1) consists of a central steering rod (15) mounted on two intermediate handles (17) and two outer handles (18) connected to the steering knuckles (2) by means of the steering knuckle lever. The steering rods are connected to each other by removable ball joints.



5.5a. Figure: OUTER BALL JOINT (lubricant-free) (PRZEGUB KULOWY DRĄŻKA ZEWNĘTRZNEGO (bezsmarowy))

1 - slip ring. 2 - stop cap, 3 - spring, 4 - outer bowl, 5 - ball pin. 6- angled tip. 7 - inner bowl, 8 - rubber cap, 9 - crown nut, 10 - pin, 11 - crown nut, 12 - pin, 13 - screw, 14 - clamping bracket. 15 - outer rod, 16 - switch lever
Installed since 01.04.1992

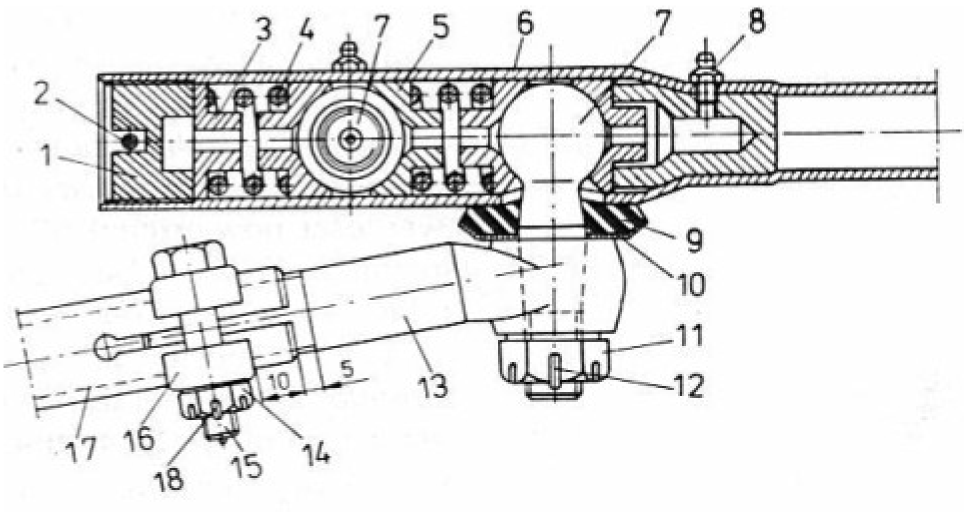
1 - pierścień osadczy. 2 - nakładka oporowa, 3 - sprężyna, 4 - miseczka zewnętrzna, 5 - sworzeń kulowy. 6- końcówka kątowa. 7 - miseczka wewnętrzna, 8 - osłona gumowa, 9 - nakrętka koronowa, 10 - zawleczka, 11 - nakrętka koronowa, 12 - zawleczka, 13 - śruba, 14 - obejma zaciskowa. 15 - drążek zewnętrzny, 16 - dźwignia zwrotnicy
Stosowany od dnia 01.04.1992 r.



5.5. Figure: STEERING ROD BALL JOINT (PRZEGUB KULOWY DRĄZKÓW KIEROWNICZYCH)

1 - inner bowl, 2 - hinge body, 3 - outer bowl, 4 - compression spring, 5 - settling ring, 6 - joint cap, 7 - ball pin. 8 - grease nipple, 9 - rubber boot of the joint. 10 - switch lever, 11 - nut, 12 - pin, 13 - lubricating channel. 14 - nut, 15 - screw, 16 - clamping bracket for rod, 17 - external steering rod, 18 - pin Pin
Installed until 31.03.1992

1 - miseczka wewnętrzna, 2 - korpus przegubu, 3 - miseczka zewnętrzna, 4 - sprężyna dociskowa, 5 - pierścień osadczy, 6 - zaślepka przegubu, 7 - sworzeń kulowy. 8 - smarowniczka, 9- osłona gumowa przegubu. 10 - dźwignia zwrotnicy, 11 - nakrętka, 12 - zawleczka, 13 - kanałek smarowy. 14 - nakrętka, 15 - śruba, 16 - obejma zacisku drążka, 17 - drążek kierowniczy zewnętrzny, 18 - zawleczka Stosowany do dnia 31.03.1992 r.



5.6. Figure: CENTRE ROD BALL JOINT (PRZEGUB KULOWY DRĄŻKA ŚRODKOWEGO)

1 - regulatory plug (M27x1). 2 - collar, 3 - spring insert, 4 - joint spring, 5 - joint bowl, 6 - central rod, 7 - ball pin, 8 - grease nipple, 9 - rubber casing, 10 - shield bowl, 11 - crown nut (M14x1,5), 12 - pin, 13 - threaded rod end, 14 - crown nut, 15 - screw (M8x38-Z-8, 8). 16 - clamping bracket, 17 - external rod, 18 - pin

1 - korek regulacyjny (M27x1). 2 - zwaleczka, 3 - wkładka sprężyny, 4 - sprężyna przegubu, 5 - miseczka przegubu, 6 - drążek środkowy, 7 - sworzeń kulowy, 8 - smarowniczka, 9 - osłona gumowa, 10 - miseczka osłony, 11 - nakrętka koronowa (M14x 1,5) 12 - zawleczka, 13 - końcówka gwintowana drążka, 14 - nakrętka koronowa, 15 - śruba (M8x38-Z-8, 8). 16 - obejma zaciskowa, 17 - drążek zewnętrzny, 18 - zawleczka

■ The outer rods (17, Fig. 5.5) have a right-hand female thread (M18 x 1,5) at one end and the same left-hand thread at the other. They shall be made of a steel tube (grade 35) with an outside diameter of 22 mm, a wall thickness of 3 mm and a length of 334 ± 1 mm (endless length). This design of the rods makes it possible to adjust the alignment of the front wheels by means of their rotation, e.g. a pipe wrench, which causes the tips to be screwed in or out of the joints, thus changing the length of the outer rods and the alignment of the wheels.

In order to prevent the outer rods and the intermediate rod from unscrewing themselves when the vehicle is in operation, they are cut off at both ends along the axles and clamped with the clamps (16) with screws (15).

■ The centre steering rod (6, Figure 5.6), made of Ø 25 x 4 mm steel tube and 607 mm long, shall be curved in the centre to 13,7 ± 3 mm in order to improve interaction with the steering rod assembly (see Figure 5.1).

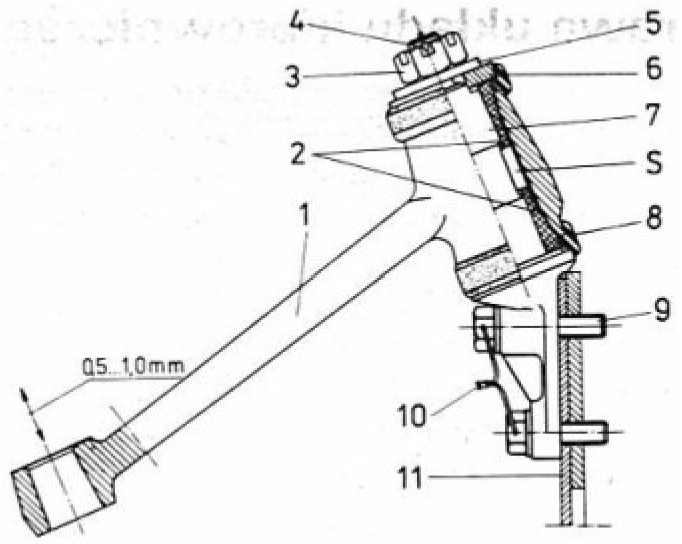
At the ends, there are sockets with internal diameter of $26^{+0.28}$ mm and length of 121+2 and 167+2 mm, in which special thread M27 x 1 is made, as well as five holes for mounting ball joints (7).

5.1.2 Return mechanism

The joint ends on the intermediate shaft (7, Fig. 5.4) are tightened with screws (3) when the gearbox worm shaft is in its central position and connected to the top shaft (16).

When mounting the steering shaft, the roller and the worm gear must be in the central position; this is achieved by aligning the marks on the gearbox housing, the worm gear shaft and the lower end of the intermediate shaft joint in a line (see setting marks B, Fig. 5.2).

■ The steering wheel (9, Fig. 5.2) with an outside diameter of 440 mm, made of plastic and reinforced with a steel frame, is mounted on a conical top shaft spline. It is fastened with a nut M16 x 1,5 (8) secured with a bent washer. The steering wheel nut has a tightening torque of 50...80 N·m.



5.7. Figure: INTERMEDIATE LEVER FOR STEERING RODS (DŹWIGNIA POŚREDNIA DRĄZKÓW KIEROWNICZYCH)

1 - swivel arm, 2 - sleeve, 3 - crown nut, 4 - pin, 5 - washer, 6 - adjustment pad, 7 - support pin, 8 - seal ring, 9 - screw, 10 - safety wire. 11 - front suspension beam, S - solid lubricant reserve (STP)

1 - ramię wychylne, 2 - tuleja, 3 - nakrętka koronowa, 4 - zawleczka, 5 - podkładka, 6 - podkladka regulacyjna, 7 - trzpień wspornika, 8 - pierścień uszczelniający, 9 - śruba, 10 - drut zabezpieczający. 11 - belka przedniego zawieszenia, S - zapas smaru stałego (STP)

■ Ball joints. The pins of the ball joints of the steering rods (7, Fig. 5.6) are fixed tilting in steel cups (5), pressed against each other by springs (4). These springs are designed to dampen the vibrations coming from the front wheels of the vehicle.

The ball pins on both ends of the centre stick (Fig. 5.6) are pressed together with the threaded plugs (1) and secured with pins (2). They are made of 15HN alloy steel, have a 0.7...1.0 mm thick carburized or nitrate sulphated surface and are tempered to a surface hardness of 53...65 HRC. The length of the pin shall be 70 mm, the diameter of the spherical head 25 mm and the diameter of the neck 17,75 mm. Ball pins operate under difficult conditions. Built in the steering rods, they are most exposed to abrasion and bending.

The ball joints of the outer rods and of the intermediate rod (fig. 5.5), whose bodies (2) are forged of carbon steel, have a socket in which the ball pin (7) is seated in the inner bowl (1) and in the outer bowl (3).

The bowl (3) is pressed against the pin by the conical spring (4) using a plate (6), which is secured with the circlip (5). The cups, which are shaped like spherical bowls, are the bearings of the ball pin head. This pin may swivel from the vertical in the body (2) of the joint by a maximum angle of 23°.

■ The joint seat (S) is filled with grease which is periodically replenished by the grease nipple (8).

5.1.2 Return mechanism

The ball joints (Fig. 5.5 and 5.6) are protected by rubber covers (9) against the ingress of dirt (e.g. sand, dust, water). Ball joints (version ii), which do not require lubrication, have been introduced in the external steering rods since 01.01.1992 (Fig. 5.5a). These joints have friction elements made of plastic, and grease nipples and grease reserves have been removed.

■ The intermediate levers (Fig. 5.7), forged from carbon steel, are attached rotationally to the supports (7), forged from alloy steel, screwed to the front suspension beam; these levers are attached to the pivots of the supports in two plastic conical bushings (2). The clamping of the sleeve in the lever, which has conical sockets, is made possible by the crown nut (3) and the adjusting washer (6). The slide bearings of the lever are lubricated with grease, which fills the space (S) between the sleeves during assembly. These bearings are sealed with two rubber rings (8).

The crown nut (3) is tightened to a torque of 20 N·m, so that the play measured at the end of the lever is 0,5...1,0 mm. After tightening, secure the nut with a lynch pin (4).

5.1.3 Repair of steering systems

The steering system is crucial for safe driving, so it is very important that deficiencies and their causes are detected early and that faults are effectively rectified in vehicle operation. Deficiencies in the steering system and how to overcome them are discussed in Table 5-2.

5.1.3 Repair of steering systems

Trouble	Reasons	Method of repair
1. Excessive force needed to rotate the steering wheel	1.1. worm bearings overloaded or worm gear misaligned.	1.1 Adjust the bearings (see section 5.1.3).
	1.2 Screw tapered roller bearing or roller bearing seized.	1.2 Replace the auger bearings or the main shaft with the roller in the ASO.
	1.3 The worm and roller are seized at the contact surface of the worm gear.	1.3 Replace the auger with the shaft or the main shaft with the roller (ASO).
	1.4 Missing or unsuitable oil grade in steering transmission.	1.4 Refill or replace oil.
	1.5. incorrect alignment of the front wheels.	1.5 Check and correct the alignment of the wheels (Section 4.2.3) in the ASO.
	1.6. ball joints of the steering rods seized.	1.6 Remove the joints, clean and lubricate or replace pins and bowls.
	1.7. Tyre pressure too low.	1.7 Inflate.
	1.8. jamming or blurring of the cross-brace bearings of the intermediate shaft joint or of the steering shaft main bearings.	1.8 Check the PTO bearings of the steering shaft and lubricate them if necessary (replace seized bearings).
2. Excessive play on the steering wheel with the wheels in the straight-ahead position	2.1 Excessive play in the toothing of the worm roller.	2.1 Adjust with the aid of the gearbox pin
	2.2 Axial clearance of the worm.	2.2 Adjust the preload of the worm bearing.
	2.3 Excessively worn-out worm gear or a roller.	2.3 Replace the worn auger with the shaft or the main shaft from the roller (ASO).
	2.4 Tighten the arm nut or steering knuckle lever or replace the worn arm and gearbox main shaft.	2.4 Tighten the arm nut or steering knuckle lever or replace the worn arm and gearbox main shaft.
	2.5. excessive joint clearance of steering rods.	2.5 Tighten the threaded plugs and adjust the joint clearances of the centre rod or replace the joints (end pieces).
	2.6 Excessive clearance of front wheel bearings.	2.6 Adjust the bearings.
	2.7. loose steering wheel connection on the shaft.	2.7 Tighten the nut or replace the wheel with a worn conical hole.
	2.8 Loose attachment for the steering transmission housing	2.8 Tighten the retaining bolts.
	2.9 Excessive clearance in the bearing retainer.	2.9 Check the condition of the PTO shaft bearing, worn out intermediate shaft joint diagonals.
	2.10. Excessive clearance in the splined spline connection on the main and worm shaft.	2.10. Tighten the clamping screws of the stern end on the main and worm shafts. of the joints on the top and worm shaft splines.

5.2. Table: STEERING SYSTEMS TROUBLESHOOTING

3. Front wheel vibrations and knocks and impacts on the steering wheel	3.1 Incorrect adjustment of the worm and roller toothing.	3.1 Adjust the toothing using the adjusting pin and washers.
	3.2 Incorrect alignment of the front wheels.	3.2 Adjust the angles of the wheels.
	3.3. Incorrect tyre pressure (excessive).	3.3 Check and correct tyre inflation pressure.
	3.4 Excessive clearance of front wheel bearings.	3.4 Set the play as described in point 4.2.3.
	3.5 Unbalanced front wheels.	3.5 Balance the wheels.
	3.6 Excessive play in ball joints or cracked springs in the centre rod.	3.6 Tighten the pins of the centre stick or replace the springs.
	3.7 Loosening of the steering transmission housing.	3.7 Tighten the bolts with the appropriate torque (Table 8-2).
	3.8 Either worn tyres or tyres with different tread types.	3.8 Replace tyres.
4. the vehicle pulls in one direction	4.1 Incorrect alignment of front wheels.	4.1 Adjust the setting of the wheels.
	4.2. front suspension spring weakened or damaged.	4.2 Replace the spring.
	4.3 Incorrect operation of one of the shock absorbers.	4.3 Check the shock absorber and replace if necessary.
	4.4 Reasons as in point 1.7 (Table 5-1).	4.4 Method of repair according to item 1.7.
	4.5. Incorrect adjustment of the brakes of one or	4.5 Check and adjust the brakes.

	more wheels.	
	4.6 Incorrect adjustment of the play in the front wheel bearings.	4.6 Adjust.
	4.7 Excessive play in the steering rods.	4.7 Adjust the centre rod play.
	4.8 Non-parallelism of the front axle of the vehicle to the rear axle.	4.8 Replace the deformed springs.

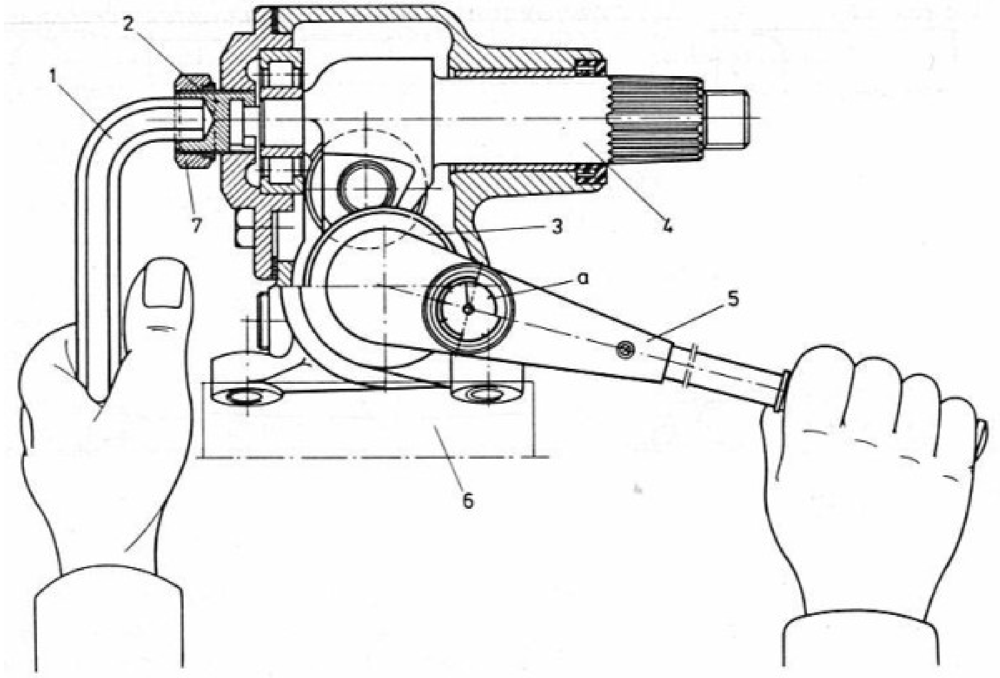
Steering system adjustment. The worm and the steering shaft are in the middle position of the gearbox (with the car wheels in the straight-ahead position and the roller in the middle of the worm). The screw is regulated by the shims (19, Fig. 5.3) of the lower bearing (20), 0,12 mm thick of non-absorbent paper and 0,25 mm thick of pressure switch. After the screw bearings have been pressed together with the bottom cover, the screw rotation torque in the bearings is checked and should be 0,5...1,0 N·m - without the roller and the main shaft. If the thrust torque is lower, the number of washers must be reduced to obtain a larger bearing clamp.

To adjust the position of the roller in relation to the screw, use the adjusting pin (2) located in the upper cover (Fig. 5.8). After the gearbox is adjusted, the resistance torque of the worm shaft is checked. The gear setting is correct when the resistance torque of the worm roller, measured at the worm shaft within 90° of the steering wheel from the centre position, is 1,6... ... 2,6 N·m.

After adjusting the gear, tighten the lock nut firmly (3, fig. 5.3). Fit the transmission arm (18) onto the main shaft (8), the bending washer (new) and tighten the nut (12) with the correct torque. The washer (11) must not rest against the main shaft flange, i.e. the transmission arm must not be placed so far against the journal tooth that the outer faces of the toothbrushes and arms are flush, but there must still be space for tightening the nut (12) of 2 mm.

After mounting the gearbox, tighten the screws of the screw cover (22), then pour 0.33 dm^3 of Hipol 15 gear oil into it and screw the plug into the filling opening.

After mounting the transmission, the column, the steering wheel and the connection of the outer rods to the steering knuckle levers, and the intermediate rod to the steering transmission arm, set the alignment of the front wheels of the vehicle and check the entire steering system at standstill and then during the test drive (see Chap. 4.2.3 for the setting of the alignment of the wheels). During the test drive, the vehicle wheels (and steering wheels) shall automatically return to their straight-ahead position after turning. An efficient steering system under normal driving conditions shall operate with a force of 35 N applied to the steering wheel (laden vehicle).



1 - spindle wrench, 2 - adjusting spindle, 3 - worm shaft, 4 - main spindle with roller, 5 - dynamometer, 6 - instrument or vice, 7 - locknut, a - dynamometer scale

1 - klucz trzpieniowy, 2 - trzpień regulacyjny, 3 - wałek ze ślimakiem, 4-walek główny z rolką, 5- dynamometr, 6 - przyrząd lub imadio, 7 - nakrętka ustalająca, a - skala dynamometru

5.8. Figure: STEERING GEAR THRUST ADJUSTMENT (REGULACJA NAPIĘCIA OPOROWEGO PRZEKŁADNI KIEROWNICZEJ)

The adjustment of the gear to the gear unit worm must be carried out as follows:

- unscrew the nut by a few turns (7, fig. 5.8),
- screw in the adjusting pin (2) with the special hook wrench (1) until the play is removed, with the steering wheel rotating without any noticeable resistance (with the front wheels of the vehicle lifted).

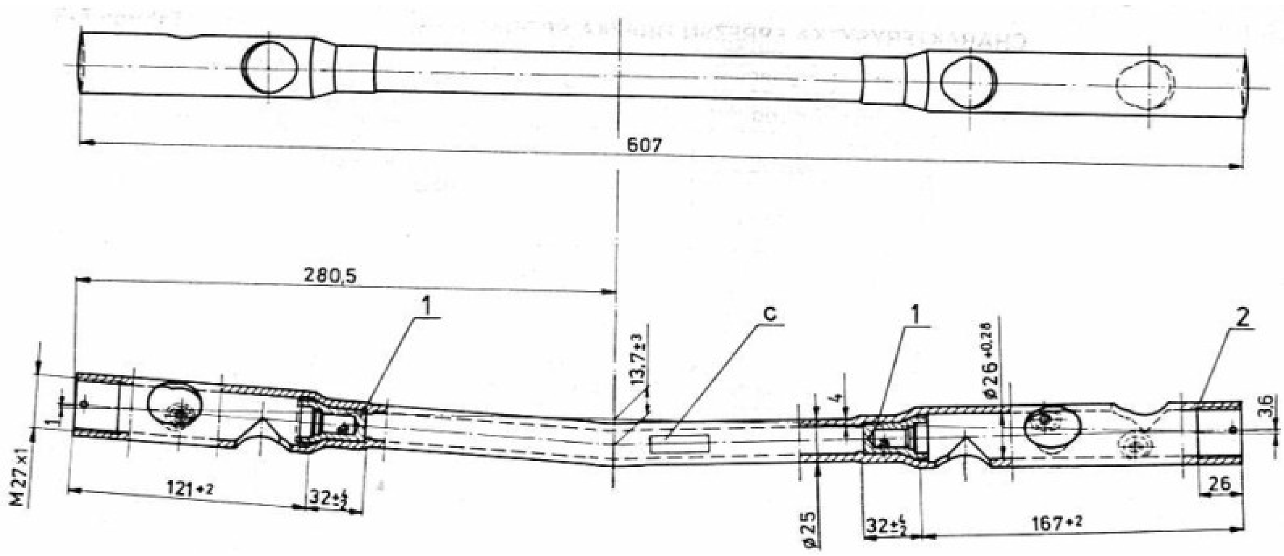
It shall also be checked that the worm shaft (23, Fig. 5.3) has no axial clearance. To do this, slide the rubber boot (25) to the left and right and check the operation of the shaft by turning the steering wheel. The clearance in the worm bearings can be eliminated by the use of adjusting washers (19).

Repair of steering equipment. All damaged, worn or insecure parts must be replaced. Remove the steering gear unit from the vehicle and only remove it if there is excessive play or significant damage. The basic operation after removing the gearbox is to check the working surfaces of the roll and the screw, which can only be checked after removing the main shaft with the roll (without having to remove the screw from the housing). If you notice exfoliation of the surface, signs of cracks or cuts, signs of excessive pressure, scratches or similar damage, replace the roller or worm. The roller bearings must not have a radial clearance greater than 0,08 mm. The diameter of the journal of the shaft per inner ring (when replacing the ring) must not be less than 18,02 mm.

The diameter of the journal for the bearing sleeves must not be less than 31,90 mm, and the outer diameter of the bearing rollers' raceways must not be less than 28,40 mm. The permissible radial clearance in the roller ball bearing must not exceed 0,1 mm.

The gearbox main shaft (8, fig. 5.3) can be used to replace the worn bearing outer raceway with rollers or the entire bearing (5) with inner ring. The defective worm shaft (23) can be replaced with a new worm shaft (27) if the worm is in good condition (the worm shaft is pressed out of the worm). Otherwise the auger is replaced together with the shaft. Also eligible for replacement is the

transmission arm (18) with damage to the polygonal teeth or an enlarged bore diameter (to be mounted on the gearbox shaft) so large that after mounting the distance from the arm to the housing front is less than 2 mm.



5.9. Figure: CENTRE STEERING ROD (WITHOUT JOINTS) (DRĄZEK KIEROWNICZY SRODKOWY (BEZ PRZEGUBÓW))

1 - joint cup socket, 2 - rod body, 3 - rod feature

1 - gniazdo miseczki przegubu, 2- korpus drążka, 3 - cecha drążka

The ball pin should adhere at least 50% to the tapered hole in the arm (18) with its tapered surface; if the contact area is smaller, drill the hole. When the diameter of the ball of the pin is less than 24,7 mm, it must be replaced. Check in the gear unit housing (among other things) the diameter of the bearing sleeve (9); if it is larger than 32.06 mm, replace the sleeve. When replacing the lower auger bearing, check the diameter of the seat for the outer ring (20). It must not be larger than 58,12 mm (the nominal diameter of the journal of the main shaft on which the bearing (5) is mounted is $20^{+0.025}$ mm). Replace the shaft with a journal with a new one with a diameter of less than 19,99 mm.

The intermediate shaft shall have no damaged fork ends, no deep scratches on the surface or signs of cracks. The nominal diameter of the bearing hole for the cross-brace is 16,016 mm. The maximum diameter of these openings shall not exceed 16,025 mm. The angular displacement of the centre line of the shaft extension pieces shall not exceed 25° (nominal size 23 ± 1°). Replace curved shafts with new ones or straighten them. Teeth have pivots with a nominal diameter of $10^{+0,012}_{-0,011}$ mm, worn pivots with a diameter of more than 9,9 mm must be replaced.

The steering column must not be cracked or bent. The nominal diameter of the bearing seats (upper and lower) is $36,3_{-01}$ mm. The column with worn bearing holes above 36,4 mm must be replaced. The steering rods must also be free from cracks, cuts, bends or play on the ball pins and from damaged internal threads. The outer rods must be straight and undamaged. Replace a rod pipe that does not meet these requirements. The hinge of the centre line, measured as shown in Figure 5.9, shall not exceed 17 mm (the hinge shall be curved in the middle to 13,7 ± 3 mm). All parts, especially ball pins, are checked very carefully and those with signs of cracks, cracks, crushing or deformation must be replaced.

The springs of the centre stick, which are pressed against the bolt cups and bent to a length of 17 mm, shall not exert a force of less than 1,2 kN. The characteristics of these springs are given in Table 5-3. The conical springs - press studs at the joint ends of the outer rods - up to a length of 5 mm shall not exhibit a pressure less than 290 N when deflected. The characteristics of these springs are given in Table 5-4. If the spring is seated, its length shall not be less than 4,3 mm. Replace springs that do not meet these requirements.

Length in free float		approximately 21 mm
Length in locked condition		up to 16 mm
Spring forces with deflection up to 17 mm	nominal	135...165 daN
	nominal	120 daN
Catalog reference	702 - 3003017	

5.3. Table: SRPING CHARACTERISTIC OF THE MIDDLE ROD (CHARAKTERYSYTKA SPRĘŻYN DRĄŻKA ŚRODKOWEGO)

Length in free float		approximately 11 mm
Highest compression at seating		up to 4,3 mm
Spring forces with deflection up to 5 mm	nominal	320...450 daN
	minimum permissible	290 daN
Catalog reference	20 - 3003069	

5.4. Table: SPRING CHARACTERISTICS OF THE ARTICULATED END (CHARAKTERYSTYKA SPRĘŻYNY KOŃCÓWKI PRZEGUBOWEJ)

All threads, especially end and rod threads, must not have damaged coils or visible cracks. When mounting the steering system after repair, tighten the screws securing the steering transmission to the frame, the nut for fixing the steering wheel and the nut for the steering rod ball pins using a torque wrench as shown in Table 8-2.

5.2 BRAKING SYSTEM

Zuk car is equipped with two independent braking systems:

- service, drum, hydraulic, dual-circuit brake with vacuum booster and brake failure indicator and with self-adjusting clearance between the front and rear wheel brake drums and shoes (self-adjusting brake mechanism introduced in cars as of 01.01.1992).
- emergency brake (or parking brake).

The service brake is applied via the dual-circuit brake pump and acts on the front and rear wheels of the vehicle simultaneously when the brake pedal is depressed. The emergency brake shall be applied by a hand lever located in the floor of the cab and shall act on the rear wheels of the vehicle only. It is designed to stop the vehicle in the event of failure of the service brake. In the car, the emergency brake is also used as a parking brake.

5.2.1 Service brake

In order to increase braking reliability and driving safety, the braking system is divided into two circuits (Fig. 5.10): the first circuit brakes the front wheels and the second the rear wheels of the vehicle. In the event of a failure in one circuit, a second circuit (and an emergency brake) is still in operation with this design solution for the hydraulic brakes. Both circuits have separate brake fluid reservoirs, located in the cabin on the right side of the driver's seat. In suspended pedal cars, the brake fluid reservoirs are mounted on the brake pump, which is available when the front cover is opened.

5.2.1 Service brake

Type	hydraulic drums
Working diameter of the brake drum Material grade Friction lining thickness - new - used Cladding width Type of cladding Fold angle (identical for all wheels) Total working surface of friction linings Idle travel of brake pedal Installation clearance between friction lining and brake drum *	280 + 0,3 mm grey cast iron 2120 5,3 - 0,3 mm min. 2,8 mm 50 - 0,5 mm Textar TE-18 120° 1172 cm^2 3...10 mm 0,5...0,75 mm
Brake pump Diameter of working cylinder Piston stroke of pump - circumference of front wheels - circumference of the rear wheels Working stroke of the piston rod Brake fluid pressure Order number of the brake pump Auxiliary equipment Working vacuum in the cylinder Diameter of working cylinder Piston stroke in cylinder	hydraulic, dual-circuit 28,57 + 0,04 mm max. 17 mm max. 14 mm max. 31 mm max. 10 MPa PH-3-29-003 pneumatic, vacuum operated, type P-1 approx. 60 kPA 158,5 mm 36,5 $^{+2}$ mm

5.5. Table: CHARACTERISTICS OF THE BRAKING SYSTEM

Diameter of expansion cylinders * - front wheels - rear wheels Brake hoses - metal - elastic Quantity and grade of brake fluid Brake failure indicator Pedal travel idle	 31,75 mm 28,57 mm steel tubes Ø 4,75 x 0,7 mm rubber, fabric reinforced, with an outside diameter of 12 mm and an inside diameter of 3,2 mm 0,4 dm^3, R3 red light on the dashboard 3...15 mm

* Brake cylinders with self-adjusting device for brake lash adjustment

The service brake system consists of the following units:

- the control, namely the brake pedal (1), the pusher (25), the assistance device (22), the brake pump (21), the brake hoses and the shoe expansion cylinders (4, and 13),
- the brake drums (26) and the shoe disc (14, 19).

The brake cylinders with their jaws are fitted to the front wheel backing plate, which are attached to the steering knuckle, and to the vaginal flange of the rear axle in the rear wheels. The jaws are

pressed against the brake drums by the pistons of the hydraulic cylinders. The front wheel brake cylinders are fitted with a simple self-adjusting system for the clearance between the shoes and brake drums.

In the rear wheel brakes, the self-adjusting clearance system is fitted to the front brake shoes (see Fig. 5.15).

The brake drums are attached to the front wheel hubs and to the flanges of the rear wheel drive semi axles. The force applied to the brake pedal (1, Figure 5.10) is transmitted by the lever system and the tendon to the valve control pin of the booster (22) and then to the piston rod of the brake pump (21). This pusher - acting on the piston of the first circuit pump and through the fluid on the piston of the second circuit - causes the brake fluid to be pumped through pipes to hydraulic cylinders, dissipating the brake shoes in the wheels.

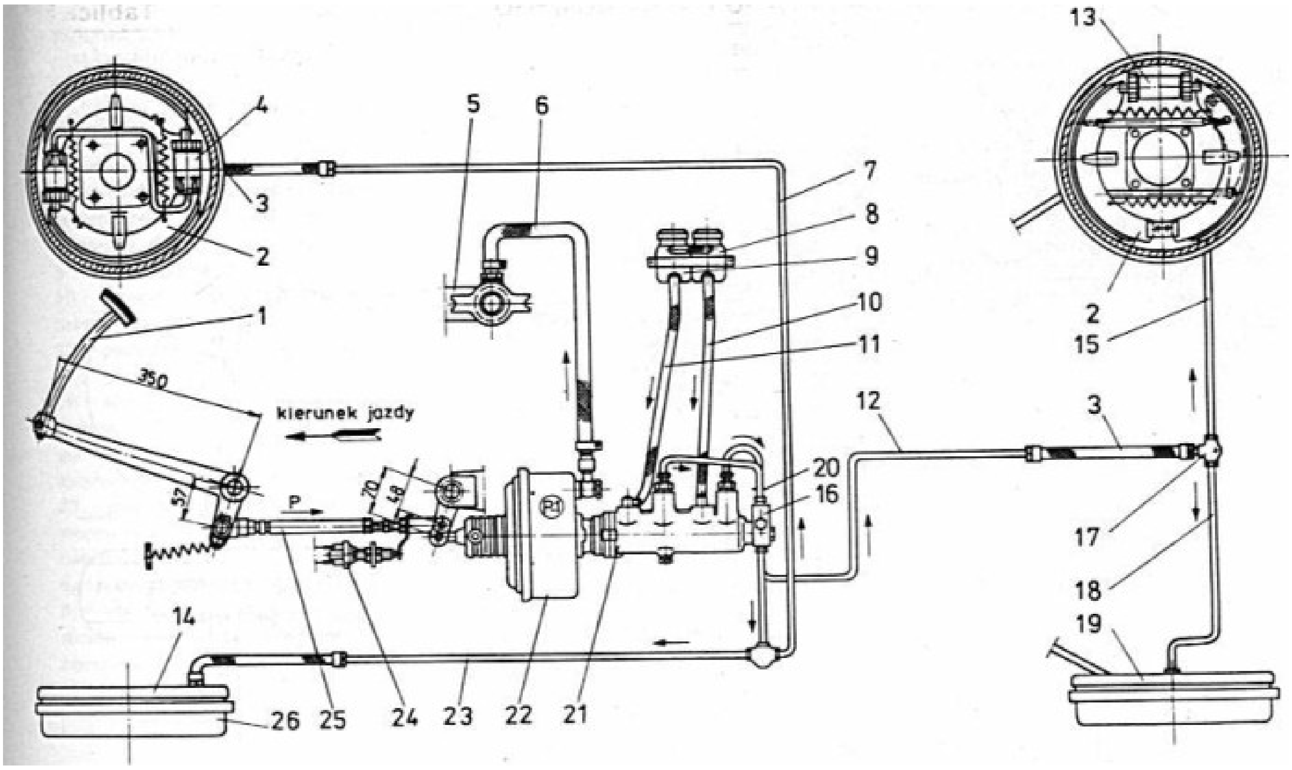
■ The vacuum booster (22), which increases the contact pressure on the brake pads, operates on the principle of the pressure difference between the atmospheric pressure in the front chamber of the cylinder and the vacuum in the rear chamber, supplied from the suction line of the engine or the vacuum pump (4C90 engine).

■ The brake pump (Fig. 5.11) consists of two pressure sections located in one housing and functionally linked. The body (8), cast in aluminium alloy, is bolted to the booster by means of a metal coupling. The piston (1) of the first section is sealed with two sealing rings (4), between which there is a collecting ring (5). The piston is protected against slipping out of the pump by a retaining washer (3). A bumper (15) is pressed into the piston, on which the sealing ring is seated. The piston is pressed against the settling ring (2) by the return spring (16) which rests against the second section piston (20) and against the spring bowl seated on the rubber piston (14).

A ball-bottomed seat is hollowed out in the piston of the pump. The pump pusher (15, Fig. 5.12) with spherical adjustment nozzle (20) is located in this seat.

The piston (20) of the second section (Fig. 5.11) is sealed in the pump casing with two pistons (19). The bumper (22), the rubber piston (14) and the spring seat (21) are similar to the piston of the first section. The return spring (23) presses the piston against the retaining screw (17) screwed into the pump casing and sealed with a seal (18).

5.2.1 Service brake



5.10. Figure: DIAGRAM OF THE DUAL-CIRCUIT HYDRAULIC BRAKING SYSTEM

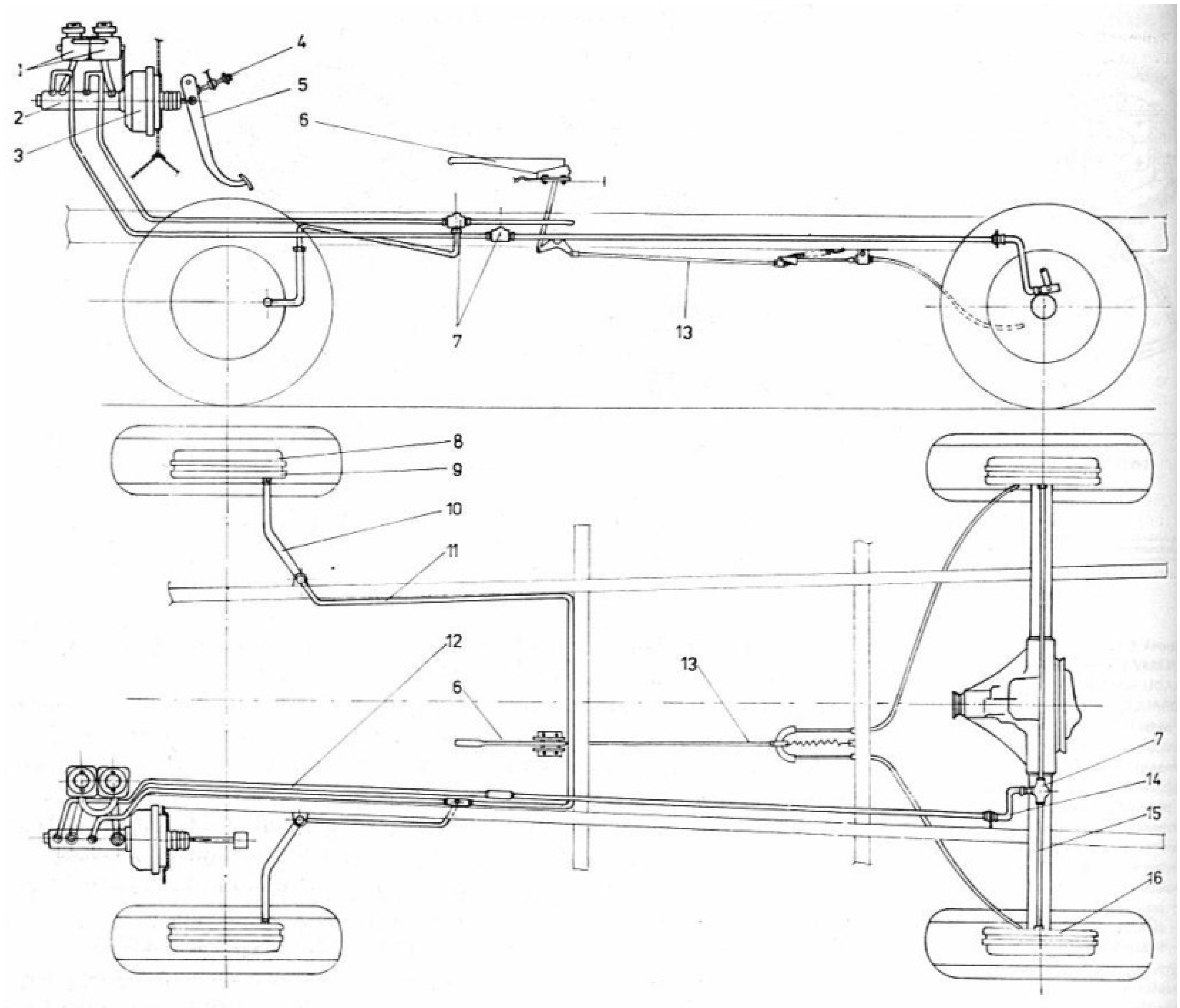
1 - brake pedal, 2 - brake shoes. 3 - brake hoses (rubber), 4 - brake cylinders for front wheels, 5 - engine suction hose, 6 - rubber hose, 7. 12, 15, 18, 23 - brake hoses (metal), 8 - brake fluid reservoir for rear wheel circumference, 9 - brake fluid reservoir for front wheel circumference, 10, 11 - cone pipes. 13 - rear wheel brake cylinders, 14 - front wheel brake disc, 16 - hydraulic brake circuit failure indicator, 17 - line connector, 19 - rear wheel brake disc, 20 - rear wheel connector, 21 - dual circuit brake pump, 22 - vacuum booster. P-1 24 - stop-lamp switch', 25 - valve stem pusher of device P-1, 26 - brake drum **Installed until 31.03.1992**

1 - pedal hamulca, 2 - szczęki hamulcowe. 3 - przewody hamulcowe (gumowe), 4 - cylinderki hamulcowe kół przednich, 5 - przewód ssący silnika, 6 - przewód gumowy, 7. 12, 15, 18, 23 - przewody hamulcowe (metalowe), 8 - zbiorniczek plynu hamulcowego obwodu kół tylnych, 9 - zbiorniczek płynu hamulcowego obwodu kół przednich, 10, 11 - przewody igelitowe. 13 - cylinderki hamulcowe kół tylnych, 14 - tarcza hamulcowa kół przednich, 16 - sygnalizator uszkodzenia obwodu hydraulicznego hamulców, 17-lacznik przewodów, 19 - tarcza hamulcowa kół tylnych, 20 - zlącze wtykowe sygnalizatora, 21 - dwuobwodowa pompa hamulcowa, 22 - podciśnieniowe urządzenie wspomagające. P-1 24 - wlącznik świateł. stop", 25 - popychacz trzpienia zaworu urządzenia P-1, 26 - bęben hamulcowy ***Stosowany do dnia 31.03 1992 r.***

In the body (8), in front of the rubber pistons (14) of the first and second sections, holes are made by means of which brake fluid from the tanks is supplied through the supply terminals (6). These tips are seated in the sockets of the pump casing and sealed. In the sockets of the housing (at the end of each piston stroke) the ends of the supply lines (9) are screwed in and sealed with washers (11). In these ends the plugs of the shut-off valves are fixed and pressed with springs.

When increasing the pressure behind the piston, the valve plug bends the valve spring (10) and the fluid flows into the wheel brake citrides. When the pistons retract, the pressure in the system is higher than behind the piston, causing the spring to deflect, the valve seat to deflect (12) and the fluid to flow back into the pump.

5.2.1 Service brake



1 - brake fluid reservoirs for the rear and front wheel periphery, 2 - double brake pump, 3 - vacuum booster, 4 - light switch ..stop", 5 - brake pedal, 6 - hand brake lever, 7 - tees, 8 - front wheel brake disc. 9 - Brake drum, 10, 14 - Brake hoses (rubber), 11, 12, 15 - Brake hoses (metal), 13 - Emergency (parking) brake mechanism, 16 - Brake disc of rear wheels
Installed since 01.04.1992

1 - zbiorniczki płynu hamulcowego obwodu kół tylnych i przednich, 2 - podwójna pompa hamulcowa, 3 - podciśnieniowe urządzenie wspomagające, 4 - wylacznik świateł ..stop", 5 - pedal hamulca, 6 - dźwignia hamulca ręcznego, 7 - trójnik, 8 - tarcza hamulca koła przedniego. 9 - bęben hamulcowy, 10, 14 - przewody hamulcowe (gumowe), 11, 12, 15 - przewody hamulcowe (metalowe), 13mechanizm hamulca awaryjnego (postojowego), 16 - tarcza hamulca kół tylnych
Stosowany od dnia 01.04.1992 r.

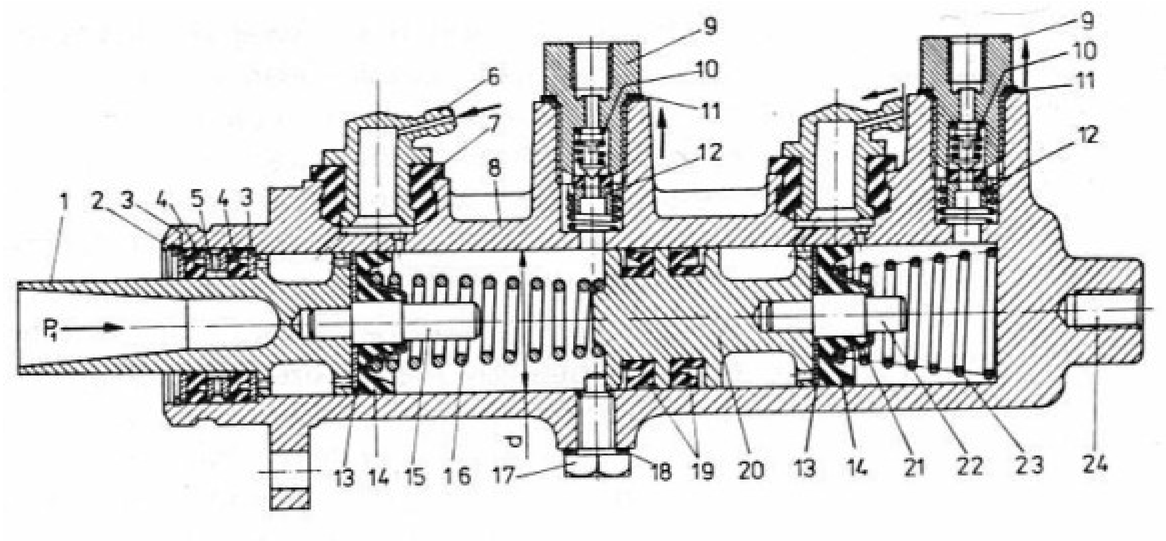
5.10a. Figure: DIAGRAM OF DUAL-CIRCUIT HYDRAULIC BRAKING SYSTEM (version II)

The preloads of the springs are selected in such a way that, after braking has stopped, an overpressure compensation of 70...100 kPa remains in the system, which prevents air from entering the braking system.If, for example, a leak occurs in the front wheel system, the piston (1) of the first section will move over the spring resistance (16) until the piston bumper rests against the piston (20) of the second section. The brake pump will then operate as a single circuit pump, but only the rear wheels will be braked.

When a leak occurs in the rear wheel circumference, the piston of section two (20) will move so that the bumper (22) will rest against the bottom of the pump casing and from now on the pump will act as a single-circuit pump with the possibility of braking only the front wheels.

■ Vacuum booster ("servo"). The purpose of this device is to increase the pressure force on the piston of the brake pump axis. produced by the use of vacuum in the suction line of the engine. Servo housing (Fig. 5.12) is a vacuum chamber made up of two parts: a cylinder (12) and a cover (9). A plastic piston (11) and a rubber diaphragm (10) are located in the cylinder. The edge of the diaphragm is fixed between the cylinder (12) and the cover (9) to form two chambers: C and D on both sides of the piston (11). The inner edge of the diaphragm is embedded in the piston groove. The special shape of the edge of the cylinder makes it easy to connect the cylinder and the cover by

inserting and turning one part relative to the other. The tightness of the connection between the two parts is ensured by the compressed outer edge of the diaphragm.



5.11. Figure: DUAL-CIRCUIT BRAKE PUMP (DWUOBWODOWA POMPA HAMULCOWA)

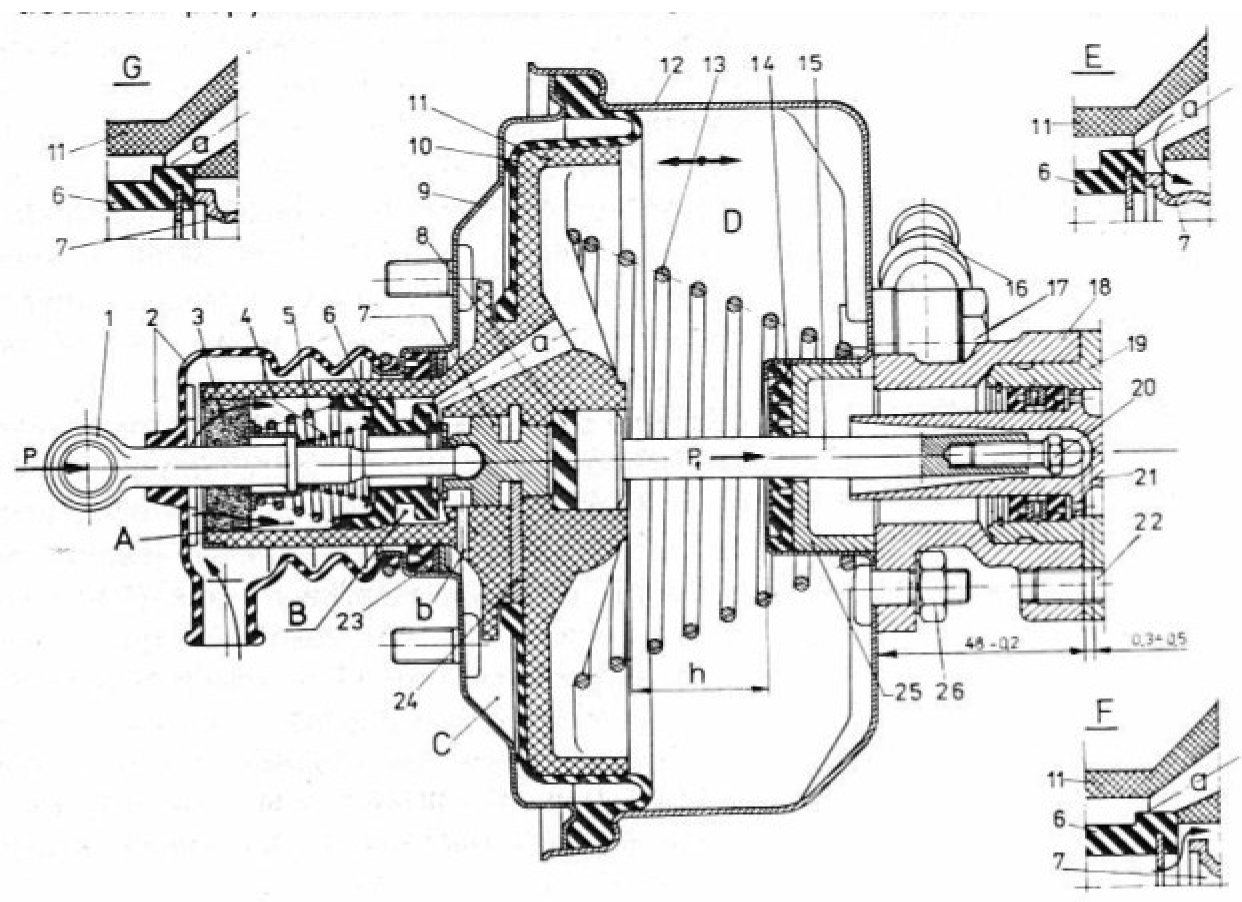
1 - front piston, 2 - circlip 32W, 3 - retaining washer, 4 - sealing ring. 5- collector ring, 6 - liquid supply connector. 7 - connector gasket (socket). 8 - pump casing. 9 - hose connection, 10 - valve spring, 11 - sealing pad, 12 - non-return valve, 13 - rubber pad, 14 - rubber pad. 15 - front piston bumper, 16 - return spring, 17 - thrust screw, 18 - gasket, 19 - rubber piston, 20 - rear piston, 21 - rear piston seat, 22 - rear piston bumper, 23 - rear spring, 24 - fixing pin for brake failure indicator d - internal diameter of the cylinder, P, - force acting on the piston of the arrow pump - direction of brake fluid flow

1 - tlok przedni, 2 - pierścień osadczy 32W, 3 - podkładka oporowa, 4 - pierścień uszczelniający. 5- pierścień zbierający, 6 - łącznik zasilania plynem. 7 - uszczelka łącznika (gniazdo). 8 - korpus pompy. 9 - króciec przewodu, 10 - sprężyna zaworu, 11 - podkladka uszczelniająca, 12 - zawór zwrotny, 13 - podkladka, 14 - tloczek gumowy. 15 - zderzak tłoka przedniego, 16 - sprężyna powrotna, 17 - śruba oporowa, 18 - uszczelka, 19 - tłoczek gumowy, 20 - tłok tylny, 21 - gniazdo sprężyny, 22 - zderzak tloka tylnego, 23 - sprężyna tylna, 24 – czop mocowania sygnalizatora uszkodzenia hamulców d - średnica wewnętrzna cylindra, P, - siła działająca na tłok pompy strzałki - kierunek przepływu plynu hamulcowego

The sleeve-shaped piston guide (11) ensures that the piston is aligned with the cylinder (12). The rubber sealant (23) prevents air from entering and the rubber cover (2) protects the ground surface of the guide sleeve against dirt and moisture. The return spring (13), located in chamber D on the right side of the piston, is designed to return the piston to its resting position. The pushrod is located in the centre hole of the piston and forms a complete unit with the pushrod (15) of the brake pump piston (21). A rubber reaction disc (8) is fitted between the pushrod piston and the piston, which, thanks to its flexibility, allows a slight movement between the two parts. The pushrod end (20) enters the ball seat of the piston rod of the brake pump (21). The rubber seal (14) ensures a tight seal between the tappet and the "servo" cylinder. The vacuum is fed from the motor suction line to the "servo" via a non-return valve in the nozzle (16). This valve also prevents petrol vapour from entering the "servo".

The sleeve part of the servo piston houses the valve piston (6, Fig. 5.12) and the metal piston (7). This piston is attached to the control pin (1) by rolling the seat at three points. The control pin (1) is connected to the brake pedal by a lever. The piston rod (7) and the control pin (1) are held in place

by the return spring (5). In this position, the internal spring (4) presses the piston (6) against the piston (7). The vacuum is fed from chamber D to the piston rod (7) via a channel "a" in the piston (11). With the piston rod (7) at rest, the piston rod channel "a" is not closed by the piston rod (6). The piston rod (7) allows vacuum to be applied to chamber C, i.e. to the left side of the piston (11).



5.12. Figure: BRAKE SERVO (PODCIŚNIENIOWE URZĄDZENIA WSPOMAGAJĄCE (serwo))

1 - control pin, 2 - rod guard -53 servo, 3 - air filter, 4 - internal spring, 5 - spring, 6 - rubber piston. 7 - metal piston, 8 - torque rod, 9 - servo cover, 10 - diaphragm, 11 - servo piston, 12 - servo cylinder, 13 - piston spring, 14 - tappet gasket, 15 - pump piston rod, 16 - line connection, 17 - hollow screw, 18 - servo connector and pump. 19 - brake pump, 20 - adjusting screw, 21 - front piston of the pump. 22- fixing screw for the pump. 23 - sealant, 24 - piston rod, 25 - guide sleeve, 26 - nut A, B, C, D - air chambers, h=36.5 + 2 mm - piston stroke, P, P_1 - forces acting on the pump piston, a, b - air flow channels. E - cross-sections through the valve without braking, F - cross-section through the valve with full braking, G - start of braking

1- trzpień sterujący, 2 - osłona cięgna -53 serwa, 3 - filtr powietrza, 4 - sprężyna wewnętrzna, 5 - sprężyna, 6 - tłoczek gumowy. 7 - tłoczek metalowy, 8- drążek reakcyjny, 9 - pokrywa serwa, 10 - przepona, 11 - tlok serwa, 12 - cylinder serwa, 13 - sprężyna tłoka, 14 - uszczelka popychacza, 15 - popychacz tłoka pompy, 16 - króciec przewodu, 17 - śruba drążona, 18 - łącznik serwa i pompy. 19 - pompa hamulcowa, 20 - śruba regulacyjna, 21 - tlok przedni pompy. 22- śruba mocowania pompy. 23 - uszczelniacz, 24 – rygiel tłoczka, 25 - tuleja prowadząca, 26 - nakrętka A, B, C, D - komory powietrza, h=36,5 + 2 mm - skok tłoka, P, P_1 - siły działające na tłok pompy, a, b - kanałki przepływu powietrza. E - przekroi przez zawór bez hamowania, F- przekrój przez zawór przy pełnym hamowaniu, G- początek hamowania

The brake pump (19) is screwed to the servo cylinder (12) via the coupling (18). The piston rod of the pump has a front screw adjustment screw (20) set to $48_{-0.2}$ mm during installation.

Operation of assistive device (servo)

1. Resting position E (Fig. 5.12)

5.2.1 Service brake

When the brake pedal is released, the control pin (1) and piston (7) are held in the parking position by the spring (13). The vacuum supply duct (a) is open and the atmospheric air outlet is closed. The vacuum generated in the engine suction line is fed via a valve at the end of the line (16) to chamber D and then via duct (b) to chamber C. In this way, the piston walls (11) are subjected to the same pressure and the piston remains stationary under the action of spring (13).

2. Braking F (Fig. 5.12)

Under pressure from the brake pedal, the control pin (1) and the piston (7) move to the right, overcoming the spring action (13). As a result of this displacement of the valve pistons (6), under the action of the spring (4) the supply of vacuum is cut off, and the open loop and duct (b) allows atmospheric air previously purified in the filter (3) to flow into chamber C. The piston (11), due to the pressure difference on both sides of the piston, moves to the right by compressing the spring (13) and moves the piston of the brake pump (21) through the reaction disc (8) and the tappet (15). When the piston of the brake pump moves to the right, the brake fluid pressure is generated and transferred to the brake cylinders, the shoes are pressed against the drums (braking). This pressure also causes a reaction force which, through the tappet (15), exerts pressure on the reaction disc (8). This disc is made of rubber, behaves like a liquid; presses on the piston (11) and presses into the hole on the right side of the piston - the valve moving it to the left, with the supply of atmospheric air G being cut off (Fig. 5.12). As a result, the piston (7) will occupy an intermediate position at which the atmospheric air passage and the vacuum supply channel are closed. In any case, the total force on the tappet (15) is equal to the sum of the pressure on the control pin (1) and the piston pressure (11).

The first part of this force comes from the driver's pressure, the second part from the servo piston. To increase the braking intensity, apply more force to the spindle (1) to increase the pressure on the reaction disc. This increased pressure is then transferred to the piston rod of the brake pump. At the same time, moving the piston (7) to the right will reopen the supply of atmospheric air.

With channel (b), air flows into chamber C, increasing the pressure on the piston wall (11), which moves to the right by an additional distance until the piston (7) cuts off the atmospheric air, the piston (7) and the piston (11) take on a new intermediate position when the pressure on the piston (7) on the BLESSE reaction disc (8) balances the new force on the control pin (1).

If the braking intensity is reduced, the reaction disc pressure (8) moves the piston (6, 1) W (8) to the left and the piston (6, 7) opens the channel (a). Part of the air from chamber C is sucked into the servo cylinder. This will reduce the differential pressure on the piston walls (11) and the force transmitted to the piston of the brake pump (21). The piston (7) and piston (11) will return to their intermediate position when the disc pressure (8) of ODETE is reduced to compensate for the reduced force on the rod, and the piston (11) will return to its intermediate position to equalise (1). When the pedal is fully depressed, the piston rod (7) moves away from the piston (6), opening the maximum passage for the atmospheric air. The air then fills the chamber to give you the maximum pressure difference on the piston walls (11), so there is maximum pressure on the piston. Any further increase in hydraulic pressure may only be achieved by applying a greater amount of force to the brake pedal. In this case, the piston (7) moves to the right until it rests against the piston (11).

3. Release of the brake

5.2.1 Service brake

When the brake pedal is released, the control pin (1) will no longer be pressed, allowing the wheel (8) and the spring (5) to move the piston (7) to the left. This shift will first close the air passage and then move the piston (6) back and open the duct (a). The connection of the CiD chambers to the engine suction line eliminates the pressure difference acting on the piston (11) and, due to the spring action (13), allows the piston, together with the tappet and the brake pump piston (21), to return to its resting position.

4. Brake operation in the absence of vacuum

The use of brakes is always possible if the vehicle has to be braked with the engine switched off or if there is no vacuum in the servo system. The pin (1) is then pressed directly against the piston of the brake pump (21) via the piston (7), the reaction disc (8) and the tappet (15). In this case, more pedal pressure is required (approx. 200 N) than when braking with the servomotor in operation.

To check the operation of the servo, press the brake pedal down firmly and start the engine. If the pedal fails, it means that the "servo" is working properly. If there is no fault, the non-return valve in the vacuum line socket (16) is damaged or the "servo" is damaged. In this case, the defective valve or the "servo" must be dismantled and repaired.

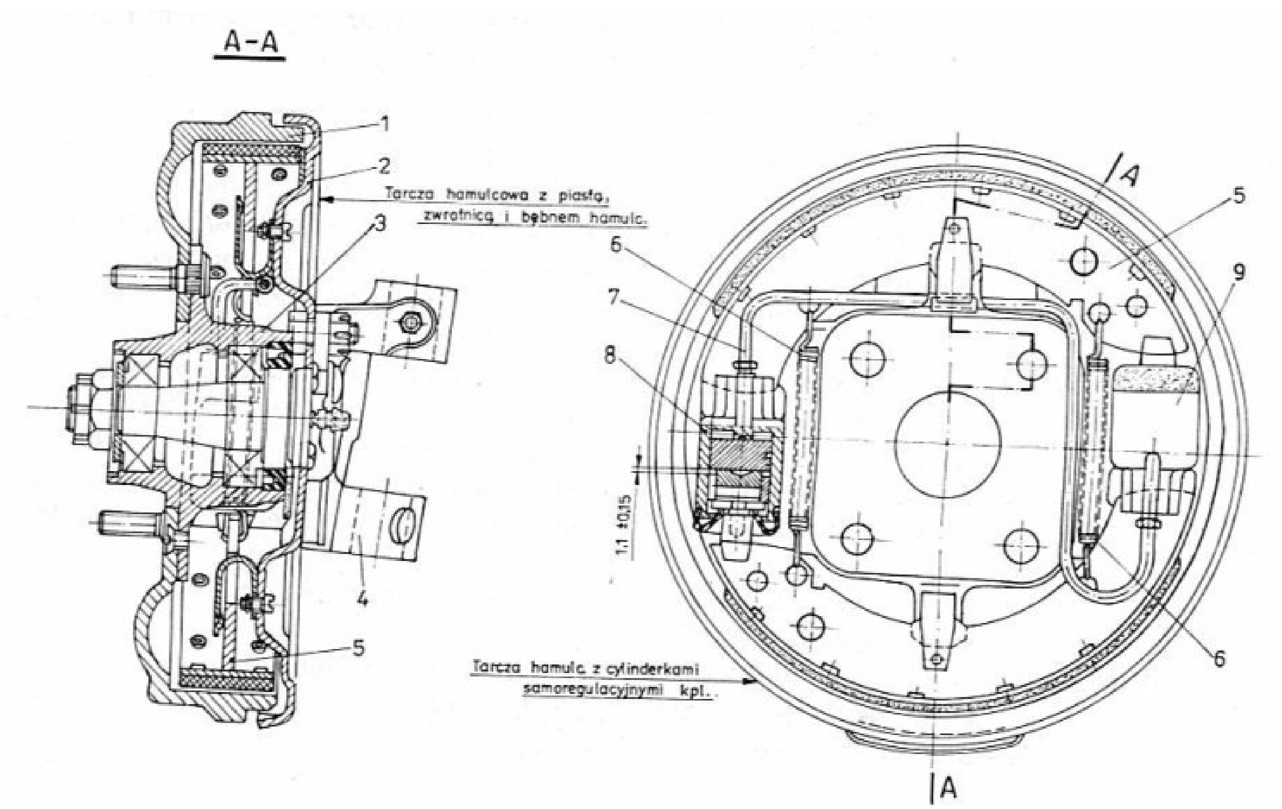
Remove the "servo" as follows:

- remove the servo" from the vehicle,
- mark the position of the cover (9, Fig. 5.12) in relation to the cylinder (12), then rotate it so that the cut-outs in the cover are opposite the creases in the cylinder and remove the cover,
- remove the cover (2) from the "servo" and slide out the piston (11) with the diaphragm (10) and the rival field (9),
- reemove the diaphragm (10) from the piston, remove the bolt (24) and then the control pin for the "servo" valve. (1) with pistons (6 and 7), springs (4 and 5) and air filter (3).

The diaphragm (10), piston (6) and disc (8) must not be damaged. These parts shall be leak-proof. The disc (8) should have a smooth, undamaged collar and its thickness should be $5.6_{-0,2}$ mm thick. The gaskets (14 and 23) should not be damaged. The piston (11) should have an undamaged seat and work with the pump piston rod (15) without jams. The adjusting screw (20) screwed into the tappet must not have any play on the thread. The springs (4,5 and 13) must not be deformed or cracked. Replace "servo parts" that do not meet your requirements. After the repair, the "servo" must be assembled in the reverse order to the order of its removal.

After assembling the "servo", adjust the length of the tappet pin as shown in figure 5.12 and install it in the vehicle's brake system.

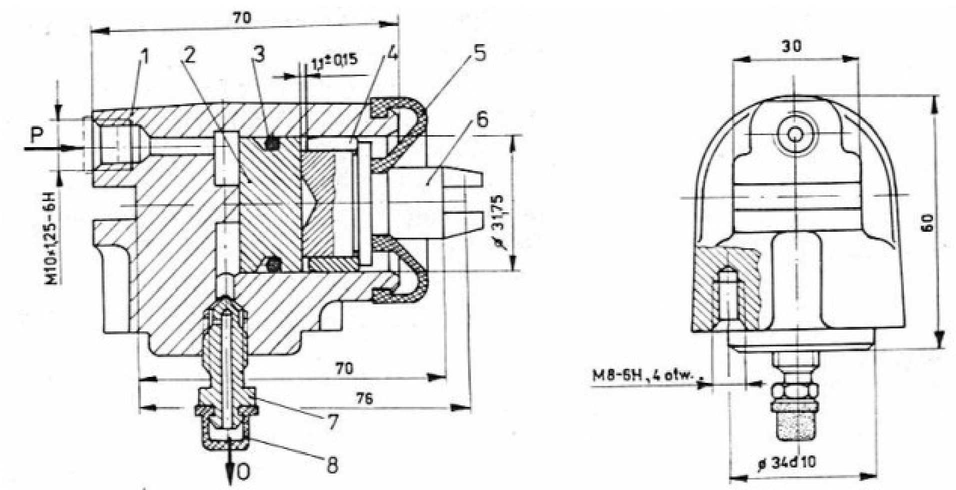
5.2.1 Service brake



5.13. Figure: FRONT WHEEL BRAKES WITH SELF-ADJUSTING CLEARANCE (HAMULCE KOŁ PRZEDNICH Z SAMOREGULACJĄ LUZU)

1 - brake drum, 2 - brake disc, 3 - wheel hub. 4 - steering knuckle, 5 - brake shoe, 6 - shoe pull spring, 7 - rigid supply line. 8 - front expansion cylinder, 9 - rear expansion cylinder

1 - bęben hamulcowy, 2 - tarcza hamulcowa, 3 - piasta kola. 4 - zwrotnica, 5 - szczęka hamulcowa, 6 - sprężyna ściągająca szczęki, 7 - przewód zasilający sztywny. 8 - cylinderek rozpierający przedni, 9 - cylinderek rozpierający tylny



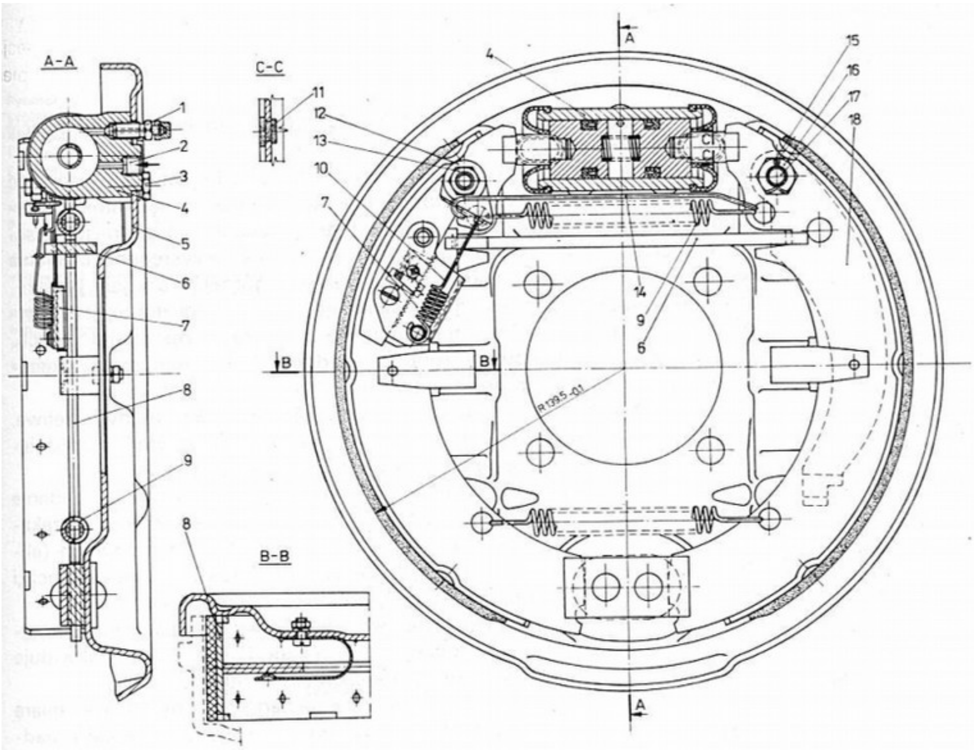
5.14. Figure: FRONT WHEEL BRAKE CYLINDER (with self-adjusting clearance)

1 - body, 2 - metal piston. 3 - sealing ring, 4 - adjusting ring. 5 - rubber boot; 6 - shoe expander pin; 7 - breather; 8 - rubber boot; P - brake fluid supply. O

1 - korpus, 2 - tłoczek metalowy. 3 - pierścień uszczelniający, 4 - sprężysty pierścień regulacyjny. 5 - osłona gumowa, 6 - sworzeń rozpierający szczęki, 7 - odpowietrznik, 8 - oslona gumowa P- doprowadzenie płynu hamulcowego. O - odpowietrznik hamulców - brake breather

5.2.1 Service brake

■ The brakes of the front wheels (Fig. 5.13) consist of a $280^{+0,3}$ mm diameter cast iron drum (1) connected to the wheel hub (3) by three M8 screws and a brake disk (2) with shoes fitted with four M12 screws to the steering knuckle. Two single-acting expansion cylinders (9.11) with automatic adjustment of the clearance between the drums and brake shoes are attached to the brake disk using M8x16 screws. The two upper and lower jaws (5) are in parallel, identical and mutually interchangeable. The brake cylinder body (1, Fig. 5.14) is made of grey cast iron, piston (2) of aluminium alloy, shoe spreader pin of steel. The working diameter of the cylinder is $31,75^{+0.039}$ mm and that of the metal piston is $31,75^{+0,025}_{-0.050}$ mm, the working stroke of the piston is 6 mm. The sealing ring (3) and the cover (5) are made of special oil-resistant rubber. When the piston (2) is inserted into the cylinder with sealing chest (3), the spring ring (4 - In some cylinders springs are used instead of the ring (4)) is pressed into place with a force of 500...700 N. The working pressure of the brake fluid in the expansion cylinders shall be a maximum of 10 MPa.



1 - brake system vent, 2 brake fluid supply channels, 3 - M8x16 cylinder fixing screw, 4 - brake cylinder (CHD-29). 5 - Brake disc, 6 - Shoe expander, 7 - Self-regulating mechanism, 8 - Brake shoe with self-regulating mechanism, 9 - Shoe retracting springs, 10 - Self-regulating spring, 11 - Rubber cap, 12 - Spring hook, 13 - M8 nut. 14 - Self-regulating string, 15 - Pin, 16 - M10 nut. 17 - Lever pin, 18 - Auxiliary brake internal lever.

1 - odpowietrznik układu hamulcowego, 2- kanałek doprowadzenia płynu hamulcowego, 3 - śruba M8x16 mocowania cylinderka, 4 - cylinderek hamulcowy (CHD-29). 5 - tarcza hamulcowa, 6 - rozpieracz szczęk, 7- mechanizm samoregulacji luzu, 8 - szczęka hamulcowa z mechanizmem samoregulacji luzu, 9 - sprężyny ściągające szczęki, 10 - sprężyna mechanizmu samoregulacyjnego, 11 - zaślepka gumowa, 12 - zaczep sprężyny, 13 - nakrętka M8. 14 - cięgno mechanizmu samoregulacji, 15 - zawleczka, 16 - nakrętka M10. 17 - sworzeń dźwigni, 18 - dźwignia wewnętrzna hamulca pomocniczego

5.15. Figure: LEFT REAR BACKING PLATE WITH SELF-ADJUSTING CLEARANCE

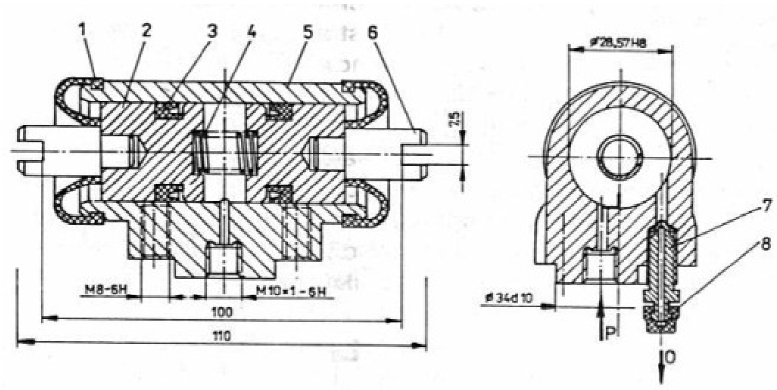
During braking, the metal pistons of the cylinders (Fig. 5.13), moved under pressure from the brake fluid, move the expansion bolts and the brake shoes (5), causing the front wheels to brake. As the friction lining and brake drum wear out, the required piston stroke for full braking will be greater than 1,1 mm, the piston and spring ring (4) in the cylinder and the shoe spreader with shoes (5) will shift and the car will be braked. This operation is a self-adjustment of the front wheel brakes.

■ Rear wheel brakes. A self-regulatory device (since 10.01.1992) is used for the rear wheels of the vehicle to regulate the play between the brake drums and the brake shoes. Backing plates with shoes and self-adjusting device are shown in Figure 5.15. They are bolted to the rear axle housing using four screws. A double-acting cylinder (4) is screwed to the top of the disc and a support riveted to the brake shoe grips is riveted to the bottom. The cast iron brake drums, with an operating diameter of $280^{+0.3}$ mm, are bolted to the half axis of the rear axle with five screws.

5.2.1 Service brake

The body of the brake cylinder (5, Fig. 5.16) is made of cast iron, the piston (2) of aluminium alloy, the shoe spreaders (6) of steel and the sealing rings (3) and the shield (1) of oil-resistant rubber.

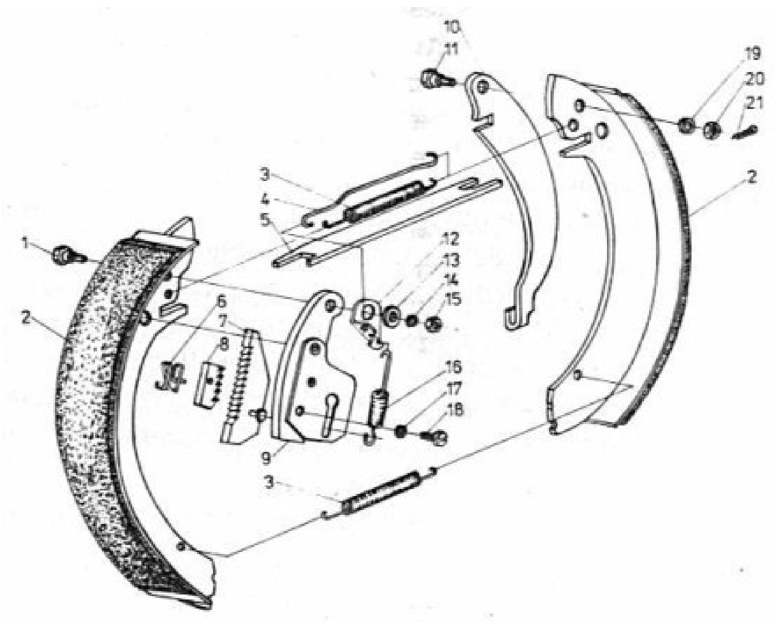
The rear brake self-adjusting mechanism (Fig. 5.15) is intended to maintain a constant play (approx. 1 mm) between the brake drum and the shoes as the friction linings and brake drums wear out (no cumbersome manual adjustment of the brake). During braking, the pistons of the brake cylinder (4) press the calipers (8) against the drum.



5.16. Figure: HYDRAULIC DOUBLE-SIDED EXPANDING CYLINDER (CHD-29) FOR REAR WHEELS

1 - rubber boot, 2 - piston, 3 - rubber boot seal, 4 - spring, 5 - body, 6 - shoe expander pin, 7 - brake breather, 8 - breather cap h = 110-100 = 6 mm (piston stroke). P - canals supplying brake fluid. O - venting the brakes

1 - osłona gumowa, 2 - tłoczek, 3 - uszczelniacz gumowy tłoczka, 4 - sprężyna, 5 - korpus, 6 - sworzeń rozpierający szczęki, 7 - odpowietrznik hamulców, 8 - osłona odpowietrznika h = 110-100 = 6 mm (skok tłoczków). P - kanalek doprowadzający plyn hamulcowy. O - odpowietrzenie hamulców



5.16a. Figure: AUTOMATIC ADJUSTMENT OF THE REAR-WHEEL BRAKES

1 - special screw, 2 - brake shoe, 3 - shoe pull spring, 4 - spring drawstring. 5- jaw expander, 6- locking spring. 7 - adjuster wedge, 8 - drawplate, 9 - adjuster wedge plate, 10 - auxiliary brake lever, 11 - lever pin, 12 - spring hook, 13 - special washer, 14 - spring washer, 15 - nut M8, 16 - adjustment wedge spring, 17, 19 - spring washers, 18 - screw M5, 20 - nut M10, 21 – pin

1 - śruba specjalna, 2 - szczęka hamulcowa 3 - sprężyna ściągająca szczęki, 4 - cięgno zaczepu sprężyny. 5- rozpieracz szczęk, 6 - sprężyna blokady. 7 - klin regulacyjny, 8 - płytka zaczepu, 9 - płytka klina regulacyjnego, 10 - dźwignia wewnętrzna hamulca pomocniczego, 11 - sworzeń dźwigni, 12 - zaczep sprężyny, 13 - podkładka specjalna, 14 - podkładka sprężysta, 15 - nakrętka M8, 16 - sprężyna klina regulacyjnego, 17, 19 - podkładki sprężyste, 18 - wkręt M5, 20 - nakrętka M10, 21 - zawleczka

During the pressing down of the jaws (braking) of the tendons (14), the spring catch (12) and spring (10) pull the mechanism (7) upwards and eliminate the play between the jaw expander (6) and the wedge. At the same time, the tendon (14) ensures a constant tension of the spring (10) as the friction linings wear out. The wedge's return movement is blocked by a ratchet. Once the pulling spring (9) has finished braking, it pulls the jaws away from the drum by a constant amount due to the clearance between the pawl and the self-regulating mechanism. As the brake linings and drums wear out, the wedge moves upwards against the next teeth and is blocked by a ratchet.

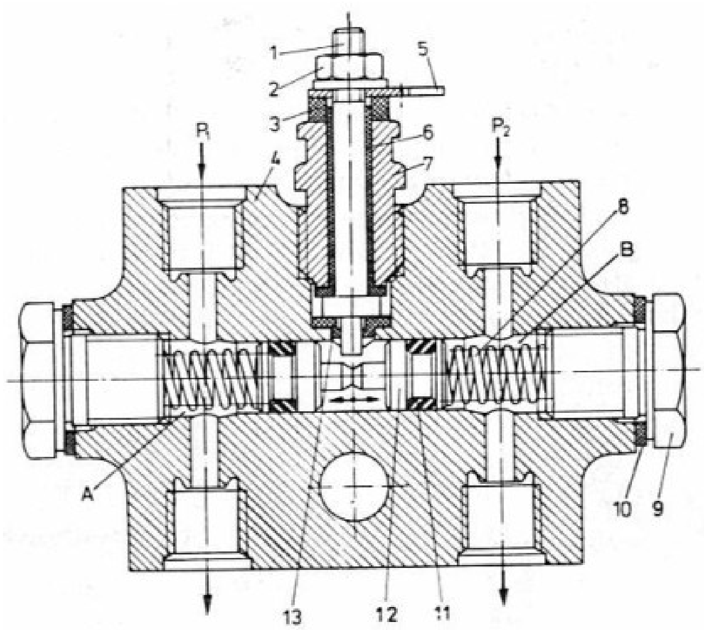
5.2.1 Service brake

The self-regulating system is also designed to ensure correct operation of the auxiliary brake during operation.

For a better orientation and understanding of the design and operation of the rear wheel brake self-adjusting mechanism, Figure 5.16a shows this mechanism in a catalog arrangement.

5.2.2 Brake failure indicator

The warning consists of a pressure sensor and an associated indicator light on the display panel. It is designed for light-signalling in the event of failure of one of the two circuits of the braking system. It consists of a cast iron body (4, Fig. 5.17) of pistons (12) with rubber sealing rings (11), springs (8) resting on threaded plugs (9) and a piston and a steel pin (1) embedded in a steel sleeve (7) and an insulating sleeve (6), an insert (13) and a washer (3) made of insulating material.



5.17. Figure: WARNING DEVICE FOR BRAKE FAILURE (SYGNALIZATOR USZKODZENIA HAMULCOW)

1 - contact pin, 2 - nut M4. 3 - insulating washer, 4 - body, 5 - plug connector, 6 - insulating sleeve, 7 - shank sleeve, 8 - spring, 9 - body cap, 10 - gasket, 11 - sealing ring, 12 - metal piston. 13 - isolation pad, A - hydraulic circuit chamber of front wheels, B - hydraulic circuit chamber of rear wheels, P_1, P_2 - working pressure of the braking system.

1 - trzpień styku, 2 - nakrętka M4. 3 - podkładka izolacyjna, 4 - korpus, 5 - złącze wtykowe, 6 - tulejka izolacyjna, 7 - tulejka trzpienia, 8 - sprężyna, 9 - korek korpusu, 10 - uszczelka, 11 - pierścień uszczelniający, 12 - tłoczek metalowy. 13 - wkladka izolacyjna, A - komora obwodu hydraulicznego kół przednich, B - komora obwodu hydraulicznego kół tylnych, P_1, P_2 - ciśnienie robocze układu hamulcowego

Type	Hydraulic
Working pressure max.	10 MPa
Piston diameter	Ø 8,7 mm
Electrical circuit voltage	12 V
Brake fluid	R3
Activation of the alarm device takes place after a circuit failure and pressure difference in the circuits.	$\triangle$ P $\geqslant$ 1,2 MPa
Weight of the siren (without fluid)	0,3 kg
Requirements and tests according to	WT-250/TZK-75
Manufacturer	WSK Wrocław

5.6. Table: BRAKE FAILURE WARNING CHARACTERISTICS

The body is divided into two flow chambers (A and B) connected to the corresponding circuits of the braking system. With the braking system working smoothly, the fluid pressure generated by the pump in chambers A and B of the alarm device causes equal pressure on the pistons (12), which

maintain a symmetrical position with respect to the axis of the contact pin (1) isolated from the mass of the body (4).

If one of the hydraulic circuits, e.g. one marked P_2, is damaged, a pressure difference occurs in the chambers (A and B) and the pressure of the fluid in the chamber (A) acting on the piston moves towards the defective circuit (P_2) to contact the contact pin, closing the electrical circuit and thus illuminating the control lamp (red) to indicate the failure of one brake circuit. When the brake pedal (pressure in the brake system P=O MPa) is released, the springs (8) return to their original position, interrupting the electrical circuit of the light-signalling device.

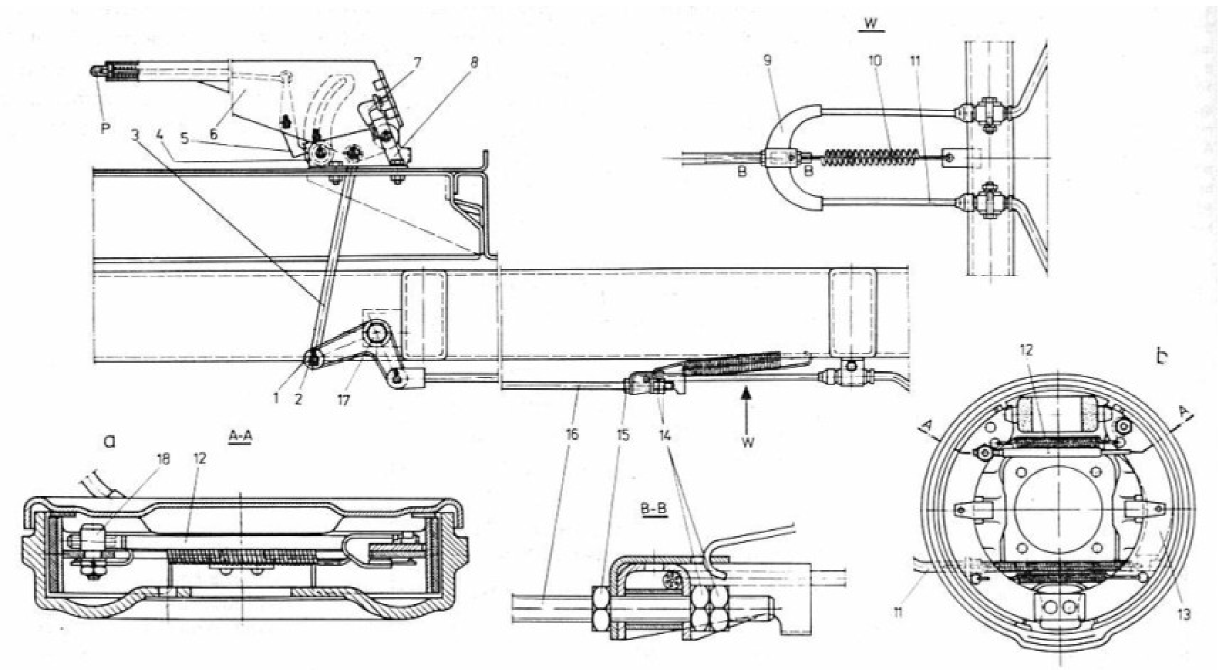
The alarm device is activated at a pressure difference in circuits $\triangle$ p $\geqslant$ 1,2 MPa.

Tighten the 26 N.m. plug connector (9, Fig. 5.17) and the 3 N·m plug sleeve (7) during the installation of the body stopper (9, Fig. 5.17).

In cars with suspended pedals, brake fluid tanks with fluid level sensors in the brake system are used instead of an alarm device.

5.2.3 Emergency (parking) brake

The parking brake (Fig. 5.18) acts on the car's rear jaws and drums via a lever and cable system. It serves to brake the vehicle while driving if both hydraulic circuits of the service brake system are damaged and as a parking brake. It is actuated by a hand lever (6) located in the floor of the cab. This lever remains in the required position due to the ratchet (5) cooperating with the sprocket (4). This lever is connected to the string (3), which through the angular lever (1) and the string (14) acts on the string hook (9). The cable (11) is connected to the inner levers of the jaws of the rear wheels.



5.18. Figure: PARKING BRAKE (HAMULEC POSTOJOWY)

1 - angular lever, 2 - pin, 3 - pull rod, 4 - pinion, 5 - ratchet, 6 - hand brake lever, 7 - control lamp switch, 8 - switch bracket, 9 - wire striker, 10 - pulling spring, 11 - parking brake cable, 12 - adjustment nuts, 13 - safety nut, 14 - wire string, 15 - lever fixing pin

1 - dźwignia kątowa, 2 - zawleczka, 3 - cięgno, 4 - zębatka, 5 - zapadka, 6 - dźwignia ręczna hamulca, 7 - włącznik lampki kontrolnej, 8 - wspornik włącznika, 9 - zaczep linki, 10 - sprężyna odciągająca, 11 - linka hamulca postojowego, 12 - nakrętki regulacyjne, 13 - nakrętka zabezpieczająca, 14 - cięgno linki, 15 - sworzeń mocowania dźwigni

During braking, the driver pulls the lever (6) upwards to rotate the angle lever (1) and tightens the cable (11). The force is transmitted to the internal levers and spreaders, the shoes are swivelled and pressed against the brake drums of the rear wheels.

To release the parking brake, press the P button at the end of the brake lever (6) and lower the lever to the lower position. When the lever is applied (brake applied), switch (7) closes the electrical circuit of the indicator light on the indicator board, which lights up red to indicate that the parking brake has been applied. The parking brake adjustment mechanism for the manual brake, as shown in Figure 5.18, section a and b, was fitted to the vehicles until 31.12.1991.

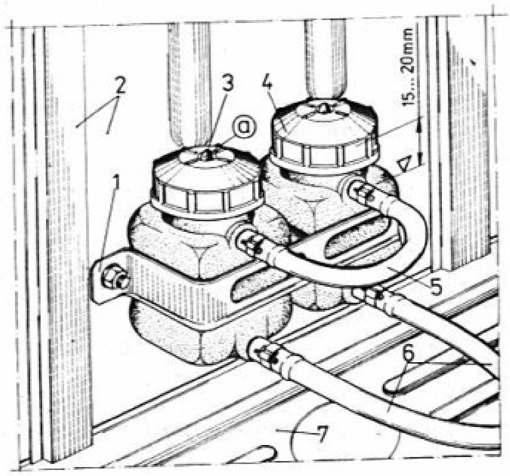
Since 01.01.1992, a self-adjusting brake system has been installed (Fig. 5.16a).

5.2.4 Repair of the braking system

An overview of brake deficiencies and their repair is given in Tables 5-7, 5-8. Any brake deficiencies shall be rectified as soon as they are detected.

> The hydraulic brake assist device 'servo' shall only be in operation with the engine running. Do not switch off the engine while driving as this will cause the brake pedal to be pressed harder (approx. 200 N) in order to brake the vehicle. In this case, the driver may be surprised by an apparent brake failure.

The most common maintenance tasks are checking the level and topping up of the brake fluid in the reservoirs (Fig. 5.19), tightness of the piping system and venting the brakes.



5.19. Figure: BRAKE FLUID RESERVOIRS (ZBIORNICZKI PŁYNU HAMULCOWEGO)

1 - handle. 2 - rear wall of cab, 3 - circumference reservoir of front wheels. 4 - rear wheel circumference reservoir, 5 - equalisation line. 6 - fluid supply lines to the brake pump, 7 - cabin floor a - vent valve
Installed until 31.03.1992

1 - uchwyt. 2 - tylna ściana kabiny, 3 - zbiorniczek obwodu kół przednich. 4 - zbiorniczek obwodu kół tylnych, 5 - przewód wyrównawczy. 6 - przewody doprowadzające płyn do pompy hamulcowej, 7 - podłoga kabiny a - zawór odpowietrzający
Stosowane do dnia 31.03.1992 r.

Venting of the brakes (purging the air). The brake system shall be vented after each fluid change, after removal of parts and repair of the brakes or in cases where it is not possible to apply any resistance to the pedal (soft pedal) at the touch of a button. Before venting, check the amount of brake fluid in the reservoirs and top up to the required level.

5.2.4 Repair of the braking system

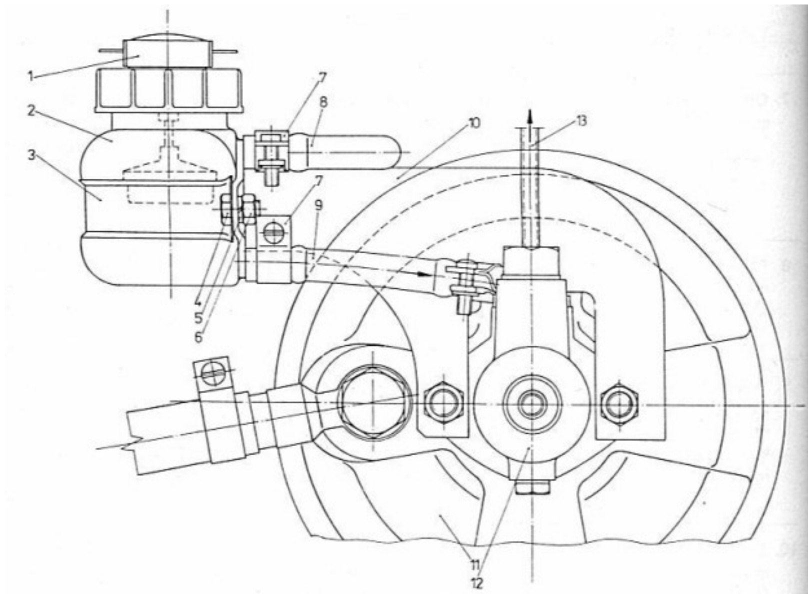
Trouble	Reasons	Method of repair
1. Fails to brake *W czasie hamowania następuje „zarzucanie" samochodu*	1.1 Brake shoe linings soaked in water or contaminated with grease.	1.1 brake several times in order to heat up the jaws and evaporate the water, rinse greased jaws with denatured grease or grind with abrasive paper.
2. Uneven brake performance - the vehicle pulls sideways	2.1 Leakage of fluid from the brake cylinder.	2.1 Replace defective or worn rubber piston, vent the entire system.
	2.2 Shoe linings contaminated with grease or brake fluid.	2.2 Rinse drums with denatured material, replace cladding or sand with abrasive paper.
	2.3. incorrectly adjusted brake shoes.	2.3 Adjust the clearance between the jaws and the drums correctly.
	2.4. piston rod of one of the cylinders seized.	2.4 Replace the brake cylinder and vent the entire system.
	2.5. line squeezed or one of the brake lines is not obstructed.	2.5 Check the system, replace damaged line or clean and vent the system.
	2.6 Insufficient liquid supply to one cylinder.	2.6 Check hoses for leaks, wash system.
3 Brake pedal locked	3.1 Front pump piston seized.	3.1 Remove the pump, replace or clean the piston, vent the system.
	3.2 Swelling of rubber pistons due to improper brake fluid.	3.2 Rinse the brake system, replace defective rubber parts and brake fluid, and vent the system.
	3.3 Impededed brake pump equalisation openings.	3.3 Clean the brake system and answer the following questions
	3.4 Brake pedal seized.	3.4 Lubricate the pedal mechanism.
4. “Soft" brake pedal (low braking effect)	4.1. Air brake system.	4.1 Ventilate the system (Chap. 5.2.3).
	4.2. broken hose for the supply of brake fluid from the reservoirs to the pump.	4.2 Replace defective line, vent the system.
	4.3 Air leakage due to insufficient air tightness.	4.3 Replace the piston rings.
	4.4. air vent in the brake fluid reservoir cover clogged.	4.4 Clean the lids of the liquid reservoirs and the clogged openings of the system.
	4.5 Insufficient brake fluid in the reservoirs.	4.5 Make up the volume in the reservoirs.
	4.6. excessive play between the shoes and brake drums.	4.6 Adjust the jaw play.
	4.7. excessively worn shoe linings.	4.7 Replace worn linings and adjust brakes.
	4.8 Excessive idle travel of brake pedal.	4.8 Adjust the idle travel of the pedal.
5. Brake pedal falls when slightly depressed (no braking effect) *Pedał hamulca zapada się po lekkim naciśnięciu (nie daje efektu hamowania)*	5.1 Large leakage of brake fluid through or from lines.	5.1 Tighten connections or replace damaged parts, refill tanks, vent the system.
	5.2 No liquid in tanks.	5.2 Fill up with liquid and vent the system.
	5.3 Inappropriate flexible hoses (expanding).	5.3 Replace the hoses with new ones.
6. Excessive travel of the brake pedal	6.1. aerated hydraulic system.	6.1 Ventilate the system.
	6.2 Low level of liquid in tanks.	6.2 Fill up with fluid and vent the system if necessary.
	6.3. rubber pistons of brake cylinders or pumps damaged or worn.	6.3 Replace used rubber pistons.
	6.4 Excessive play between jaws and drums or worn out jaw friction linings.	6.4 Adjust slack or replace linings.
7. Limited "hard" travel of the pedal *Ograniczony „twardy" skok pedału*	7.1 Low or no idle travel of brake pedal.	7.1 Adjust the idle travel of the pedal to 3...15 mm (Chap. 5.2.3).
	7.2 Too little clearance between the shoe friction linings and the brake drums.	7.2 Adjust the position of the brake shoes.
	7.3 Dirty compensating holes in the brake pump.	7.3 Clean and vent the system.
	7.4. brake shoe retracting springs damaged.	7.4 Replace damaged springs.
8. the pedal does not return to its normal position after braking	8.1 Weakened jaw retracting springs.	8.1 Replace the springs.
	8.2 Breaked return spring.	8.2 Replace damaged spring.
	8.3 Brake pump bent tappet.	8.3 Straighten the tappet or replace it with a new one.

5.7. Table: BRAKING SYSTEM TROUBLESHOOTING

9. Applying the brake requires more force to be applied to the pedal than usual (lower braking effect)	9.1. defective booster or rubber line connecting the engine suction manifold to that booster.	9.1 Replace damaged rubber hose or booster.
	9.2. swollen rubber pistons and seals throughout the system by using the wrong brake fluid.	9.2 Replace damaged rubber pistons and seals with new ones and vent the system (ASO).
10. Hydraulic brake circuit defective (low braking effect) and control indicator (red) on dashboard not illuminated	10.1. faulty brake failure indicator, e.g. metal pistons clogging the brake lines (venting the analyser or damaging the system at the same time). rubber hoses to the hydraulic circuits of the front and rear wheels	10.1 Repair the indicator
	10.2. brake pump circuit defective.	10.2 Repair the brake pump (vent the system).
	10.3. Burnt-out control lamp bulb.	10.3 Replace burnt-out bulb.
11 Absence of stop-lamps when the brake pedal is depressed	11.1 Burnt-out lamp in lamp.	11.1 Replace bulb.
	11.2 Damaged light contactor, 'stop'.	11.2 Replace defective contactor (mounted on car frame).
	11.3 Burnt-out fuse 1-9 (8-A).	11.3 Eliminate the cause and replace the fuse.

Trouble	Reasons	Method of repair
1. Brake inoperative when lever is applied	1.1. oiled, worn or soaked friction linings of the brake shoes of the rear wheels.	1.1 Rinse, dry or replace friction lining, soaked that it is dried by braking the vehicle several times
	1.2 Incorrect adjustment of the play between the shoes and brake drums.	1.2 Adjust the slack in the brake shoes on the rear wheels.
2. There is no braking effect over the entire stroke range of the lever.	2.1 Cables pulled out or not properly adjusted.	2.1 Adjust the rope tension (Chap. 5.2.3).
	2.2 Excessive play between the spreader and the brake shoes.	2.2 Delete the play.
3. When the lever is engaged and released, the rear wheels are braked	3.1. blurred cables in the armour.	3.1 Clean the cables and lubricate them.
	3.2 Frozen cables in the armour (winter in the cold season).	3.2 Degrease the ropes (e.g. with hot water), clean them and lubricate them with grease (STP).
4. When the brake lever is applied, the red indicator on the indicator plate does not illuminate.	4.1. control indicator switch (with brake lever on) defective.	4.1 Replace defective switch.
	4.2. Burnt-out control lamp bulb.	4.2 Replace burnt-out bulb.

5.8. Table: EMERGENCY BRAKING SYSTEM TROUBLESHOOTING



5.19a. Figure: BRAKE FLUID RESERVOIRS (ZBIORNICZKI PŁYNU HAMULCOWEGO)

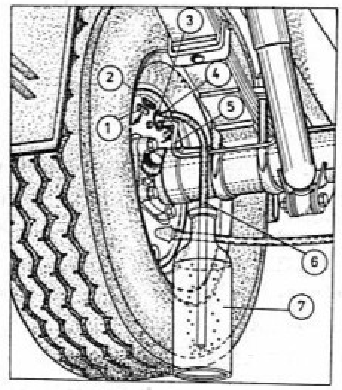
Installed since 01.04.1992
1 - the cover with the sensor, 2 - the brake fluid reservoir, 3 - the tank mounting bracket, 4 - the screw. 5 - spring washer. 6 - nut, 7 - hose tie, 8 - brake fluid equalisation line, 9 - brake fluid line, 10 - tank fixing bracket, 11 - brake servo. 12 - brake pump (PH3-29). 13 - brake hoses

Stosowane od 01.04.1992 r.
1 - pokrywa z czujnikiem, 2 - zbiorniczek płynu hamulcowego, 3 - obejma mocowania zbiorników, 4 - śruba. 5 - podkładka sprężysta. 6 - nakrętka, 7 - opaska przewodu, 8 - przewód wyrównawczy plynu hamulcowego, 9 - przewód płynu hamulcowego, 10 - wspornik mocowania zbiorników, 11 - serwo hamulcowe. 12 - pompa hamulcowa (PH3-29). 13 - przewody hamulcowe

If only the front wheel brakes or only the rear wheel brakes are repaired, only one (repaired) circuit must be vented:

- clean the breather (4, Fig. 5.20) on the brake disk from mud and dust and remove the rubber casing;
- place the needle roller tube on the breather and immerse the other end in the brake fluid in the bottle, then place the key on the breather;
- press the brake pedal with the vent removed by less than a full turn, then tighten the vent and release the pedal pressure slowly (repeat this step until no air bubble brake fluid escapes from the line);
- put the rubber cap on the vent.

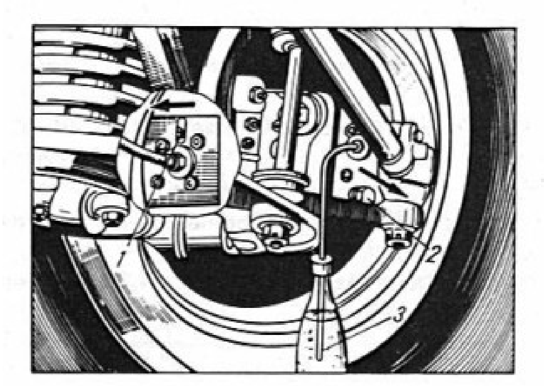
Ventilate the brakes on the other wheels in the same way. Before venting the cylinder, the brake fluid must be added to a suitable reservoir in each subsequent wheel and the fluid must be topped up during venting. If bleeding takes too long (air bubbles are constantly coming out), the brake system is leaking. In this case, find and remove any leaks.



5.20. Figure: VENTING THE BRAKES OF THE LEFT REAR WHEEL

1 - control window, 2 - rubber stopper. 3 - a brake cylinder, 4 - a vent, 5 - a brake hose. 6 - needle roller tube, 7 - brake fluid bottle

1 - okienko kontrolne, 2 - korek gumowy. 3- cylinderek hamulcowy, 4 - odpowietrznik, 5 - przewód hamulcowy. 6 - rurka igielitowa, 7 - butelka z płynem hamulcowym



5.21. Figure: VENTING THE BRAKES OF THE LEFT FRONT WHEEL

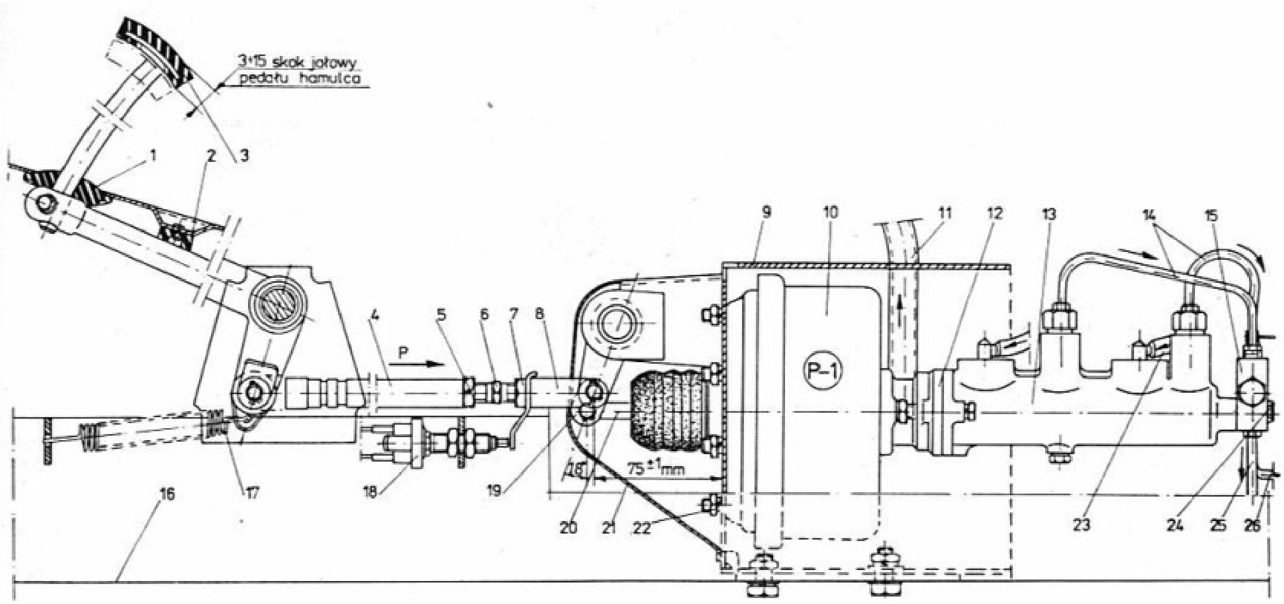
1, 2 - rubber caps 3 - transparent hose in brake fluid bottle

1, 2 - zaślepki gumowe 3 - przewód przezroczysty w butelce z płynem hamulcowym

Control of the idle stroke of the brake pedal. The idle travel of the brake pedal should be 3...15 mm (Fig. 5.22). If the pedal travel is too small, unscrew the lock nuts (5 and 7), then screw the adjusting switch (6) into the lug (8) and tappet (4) using a wrench, retaining a check dimension of 75 ± 1,0 mm. Adjust the idle travel of the pedal so that, when the pusher is connected to the shorter arm of the brake pedal, the longer arm of the pedal rests against the rubber buffer of the pedal (2) below the floor pan when the control pin (20) is freely in place. In cars with suspended pedals (Fig. 5.22a), the idling travel of the brake pedal is not regulated.

Parking brake adjustment. A correctly adjusted brake should ensure that the vehicle is braked and maintained on a firm and dry surface, with the brake lever in the extreme, upper position (there should still be enough space for the ratchet of about 5 teeth). If these requirements are not met, adjust the brake. The adjustment consists in changing the length of the tendon (14, fig. 5.18) connecting the lever arm (1) with the cable drawbar (9). To do this, unscrew the counter nut (13)

and determine the working length of the cable (14) and the required cable tension (11) by unscrewing or unscrewing the nuts (12).



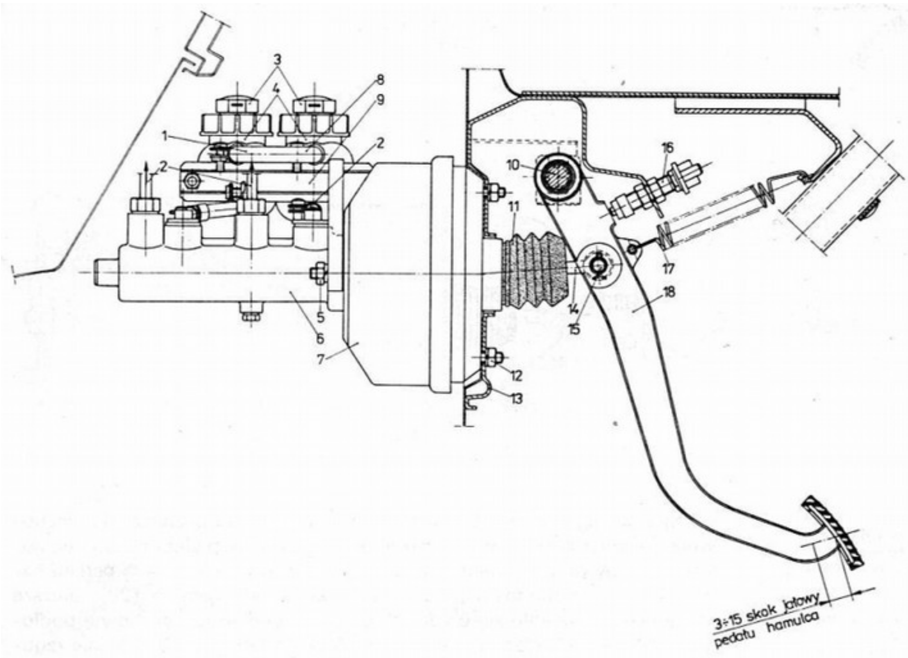
5.22. Figure: BRAKE APPLICATION MECHANISM

Installed until 31.3.1992

1,2 - pedal rubber buffers, 3 - brake pedal, 4 - booster piston rod, 5,7 - locknuts, 6 - adjuster coupling, 8 - pusher tip, 9 - booster mounting bracket, 10 - vacuum booster, 11 - vacuum tube, 12 - pump coupling. 13 - dual-circuit brake pump. 14, 25 - front wheel circumference brake lines, 15 - signal, 16 - car frame, 17 - brake pedal return spring, 18 - contactor brake lights, stop, 19 - stem lever, 20 - valve stem, 21 - valve cover, 22 - nut, 23 - tank to pump lines, 24 - screw, 26 - rear wheel circumference brake line.

Stosowany do 31.03.1992 r.

1,2 - zderzaki gumowe pedalu, 3 - pedał hamulca, 4 - popychacz tłoka urządzenia wspomagającego, 5,7 - przeciwnakrętki, 6 - łącznik regulacyjny, 8 - końcówka popychacza, 9 - wspornik mocowania urządzenia wspomagającego, 10 - podciśnieniowe urządzenie wspomagające, 11 - przewód podciśnieniowy, 12 - łącznik pompy. 13 - dwuobwodowa pompa hamulcowa. 14, 25 - przewody hamulcowe obwodu kół przednich, 15 - sygnalizator, 16 - rama samochodu, 17 - sprężyna powrotna pedału hamulca, 18 - stycznik Światel hamowania „stop", 19 - dźwignia trzpienia, 20 - trzpień sterujący zaworem, 21 - oslona ..serwa", 22 - nakrętka, 23 - przewody od zbiorniczków do pompy, 24 - śruba, 26 - przewód hamulcowy obwodu kół tylnych



5.22a. Figure: BRAKE APPLICATION MECHANISM

Installed since 01.04.1992

1 - brake hoses. 2 - pump supply lines. 3 - lids with fluid sensors, 4 - brake fluid reservoirs. 5 - fixing nut for the pump. 6 - brake pump (PH3-29). 7 - vacuum booster (...servo"). 8 - liquid equalisation line in tanks, 9 - tank clamps, 10 - pedal fixing roller. 11 - pusher cover, 12 - attachment nut, "servo". 13 - cabin wall. 14 - piston rod, 15 - pin, 16 - light switch ... stop", 17 - pedal drawbar spring, 18 - brake pedal (suspended)

Stosowany od 01.04.1992 r.

1 - przewody hamulcowe. 2 - przewody zasilające pompe. 3 - pokrywy z czujnikami płynu, 4 - zbiorniczki płynu hamulcowego. 5 - nakrętka mocowania pompy. 6 - pompa hamulcowa (PH3-29). 7 - podciśnieniowe urzadzenie wspomagające (..serwo"). 8 - przewód wyrównawczy płynu w zbiorniczkach, 9 - obejma zbiorniczków, 10 - walek mocowania pedałów. 11 - osłona popychacza, 12 - nakrętka mocowania „serwa". 13 - ściana kabiny. 14 - popychacz tłoka, 15 - zawleczka, 16 - włącznik światla ..stop", 17 - sprężyna ściągająca pedał, 18 - pedal hamulca (podwieszony)

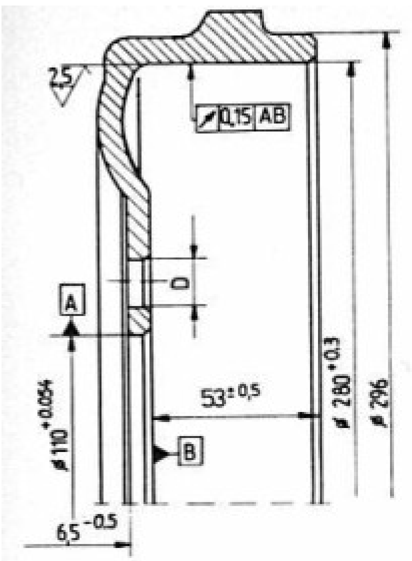
If this adjustment is not effective, which may occur if the brake linings are worn out to a large extent, release the rope tension, remove the rear wheels, drums and brake shoes of both wheels. Then the jaw expanders are removed from the jaw sockets to eliminate the excessive clearance between the spreaders and the rear jaws. After this adjustment, the system must be assembled and the appropriate brake cable tension determined (for cars without self-adjusting the brakes).

In addition to the adjustment described above, the parking brake is also serviced by periodically checking the cleanliness, cleaning and lubricating the joints of the lever system and the ropes with grease (STP) or engine oil.

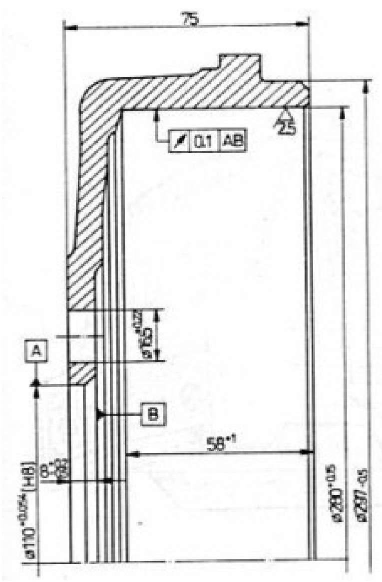
Before repairing the braking system, lift the vehicle and place it on the racks, remove the wheels and remove brake fluid from the entire system. To remove the liquid, loosen the air vent and pump with the brake pedal until the liquid stops leaking. After removing the brakes, carefully wash the metal parts with kerosene and verify them.

Before repair, check the tightness of the brake pump together with the booster. The pump shall maintain a maximum control pressure of 12 MPa brake fluid for 60 seconds and a "servo" control vacuum of approximately 50 kPa.

The tightness of the brake pump may also be checked by means of compressed air at a pressure of 150...200 kPa. The pressure indicated by the pressure gauge shall not decrease within 10 seconds. Pump nozzles with diameters greater than 28.65 mm are not suitable for further use. Pistons with diameters smaller than 28.50 mm must be replaced. Rubber packing pistons and chest seals are recommended to be replaced with new ones during each main repair. The front and rear springs of the brake pump (16, 23, Figure 5.11), when bent to a length of 27 mm and 21 mm respectively, shall not exhibit a force of less than 60 N and 110 N.



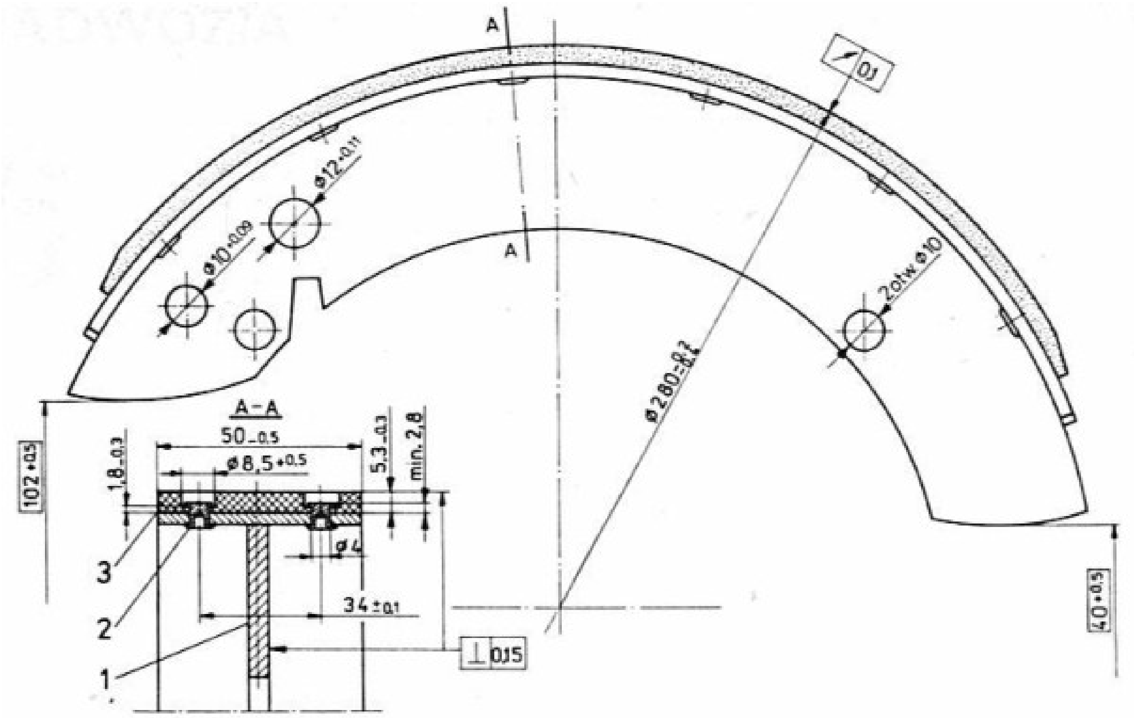
5.23. Figure: BRAKE DRUM (INSPECTION DIMENSIONS) for rear axle type 18



5.23a. Figure: BRAKE DRUM 3251 (INSPECTION DIMENSIONS)

■ The brake drums (Fig. 5.23) must not have cracks or deep cracks. If excessive wear of the working surface of Ø 280 mm (ovalisation, conical) is detected, the drum must be ground or milled. The layer of removable material shall be as thin as possible. If the drum is worn over the

permissible diameter of 283 mm, scrap the drum. The roughness of the working surface of the drum shall not exceed 2,5 µm and the radial run-out 0,15 mm. The drum must be machined on the wheel hub.



1 - friction lining, 2 - brass rivet (4x7), 3 – jaw

1 - okładzina cierna, 2- nit mosiężny (4x7), 3 - szczęka

5.24. Figure: BRAKE SHOE WITH FRICTION LINING (SZCZĘKA HAMULCOWA Z OKŁADZINA CIERNA)

■ Brake jaws. Brake shoes with riveted friction linings or shoes with glued linings are used in the brakes. The brake shoes (Fig. 5.24) must not be damaged. Friction linings shall not be cracked or crushed, shall adhere to the entire surface of the jaw and shall have no slack in the fastening rivets. Small greases on the cladding surfaces can be removed by washing them with denatured water and then drying them with compressed air. Riveted linings with a minimum thickness of less than 2.8 mm must be replaced. Brass rivets 4x7 mm should be used to fix the brake pads both when repairing riveted brake shoes and when fitting glued brake pads.

Used adhesive or riveted linings on the jaws shall be removed, the surface of the jaws shall be cleaned (with a scraper), a new liner shall be applied to the jaw and riveted as shown in Figure 5.24.

5.2.5 Brake performance

The service brake must be such that the braking force of the wheels on both sides of the same axle is uniform. The efficiency of the brakes is determined by measuring the length of the braking distance from 30 km/h to stopping the vehicle. The unladen vehicle, when braking (for cold brakes) on a horizontal road with an asphalt surface, clean and dry, when braking without locking any of the wheels, shall retain its principal direction of motion and the braking distance measured from the place where the driver applied the brake to the place where it stops shall not exceed for

- service brake 12,5 m,
- parking brake 25 m.

5.2.5 Brake performance

When measuring the braking distance, the foot pressure on the brake pedal must not exceed 700 N and the foot pressure on the parking brake levers must not exceed 200 N (according to EN 76/S-47000).

The efficiency of the brakes is usually determined by measuring the braking force on the wheels of the vehicle on a roller stand in the service station. This measurement is easy to make and also gives you the most information about brake performance and the location of the malfunction.

The unladen vehicle braking forces measured at the periphery of the wheels shall be as follows

- the service brake:
  - front wheels 4600(2x2300)N
  - rear wheels 3400(2x1700)N
- the parking brake:
  - rear wheels 1680(2x840)N

The difference in braking forces between the wheels on one axle must not exceed 25%, assuming a 100% greater force.

6 VEHICLE BODIES

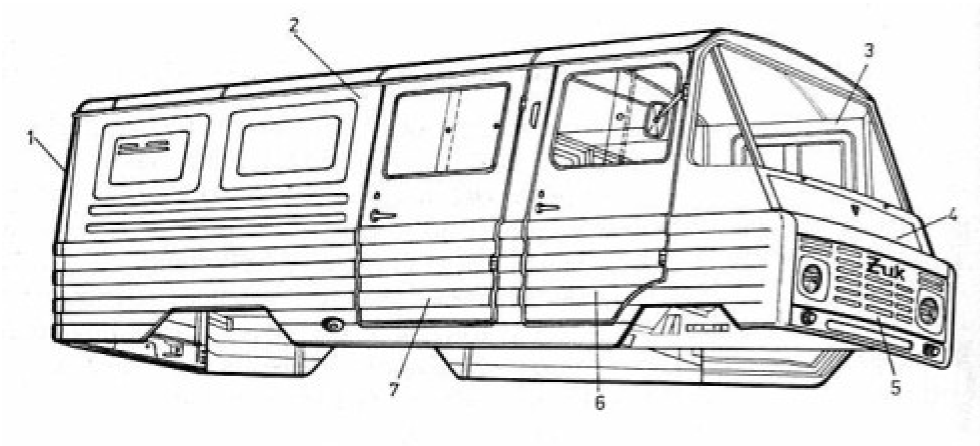
The bodies are adapted to various needs of the users, thanks to which the family of these cars has a dozen or so varieties. Bodies can be divided into two groups (Table 6-1):

- universal van-type bodywork, with a cab forming a whole with the rear part of the bodywork attached, intended for the carriage of goods and passengers (see 6.1),
- bodywork comprising a cab and a load compartment, which are separate, independent structures fixed to the frame (see Figure 6.15).

6 VEHICLE BODIES

1	Universal van	A 06	Commodity
2	Special van	A 062	For the transport of valuables
3	Commodities and persons	A 07	Freight and passenger
4	Microbus	A 1801	9 persons
5	Firefighting	A 15, A 151	With water-pump
6	Pickup	A 111, A 161	Load platform
7	Isothermal	A 17, A 177	Separated from the cab
8	Containers	A 171	
9	Refrigerator	A 175	

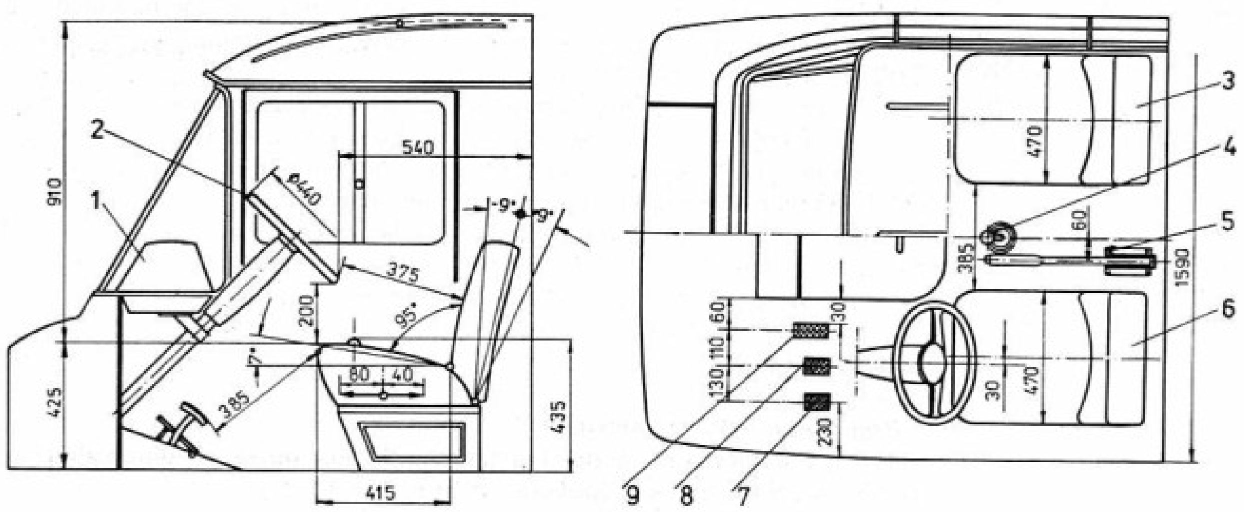
6.1. Table: BODY TYPES



6.1. Figure: CAR BODY ZUK A06 - VAN

1 - rear door, 2 - body, 3 - cab window. 4 - cab cover. 5 - air inlet cover, 6 - right cab door, 7 - cargo compartment door

1 - drzwi tylne, 2 - nadwozie, 3 - szyba kabiny. 4 - pokrywa kabiny. 5 - oslona wlotu powietrza, 6 - drzwi prawe kabiny, 7 - drzwi przedziału ladunkowego



6.2. Figure: DIMENSIONS OF THE DRIVER'S PLACE

1 - dashboard. 2 - steering wheel, 3 - passenger seat. 4 - shift lever, 5 - emergency brake lever (parking brake), 6 - driver's seat. 7 - clutch pedal, 8 - brake pedal, 9 - acceleration pedal

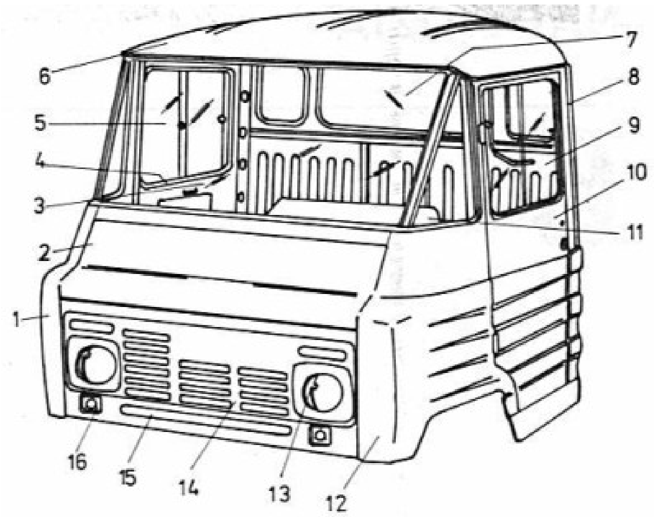
1 - obudowa tablicy rozdzielczej. 2 - koło kierownicy, 3 - fotel pasażera. 4 - dźwignia zmiany biegów, 5- dźwignia hamulca awaryjnego (postojowego), 6 - fotel kierowcy. 7 - pedał sprzęgla, 8 - pedal hamulca, 9 - pedal przyspieszenia

6.1 BODY A06

6.1 BODY A06

The car body of the A06 van (Figure 6.1) consists of a cabin and a load unit welded together as shown in Figure 6.4.

6.1.1 Cabin



1, 12 - cab corners, 2 - top cover, 3 - cab windscreen, 4 - right door, 5 - door glass, 6 - cab roof, 7 - cab rear window, 8 - complete cab, 9 - rear wall, 10 - left door. 11 - dashboard housing, 13 - reflector mounting socket, 14 - air inlet housing, 15 - cab mounting panel, 16 - direction indicator lamp mounting socket

1, 12 - narożniki kabiny, 2 - pokrywa górna, 3 - szyba przednia kabiny, 4 - drzwi prawe, 5 - szyba drzwi, 6 - dach kabiny, 7 - szyba tylna kabiny, 8 - kabina kompletna, 9 - ściana tylna, 10 - drzwi lewe. 11 - obudowa tablicy rozdzielczej, 13 - gniazdo mocowania reflektorów, 14 - osłona wlotu powietrza, 15 - płyta nośna kabiny, 16 - gniazdo mocowania lampy kierunkowskazów

6.3. Figure: A111 CABIN

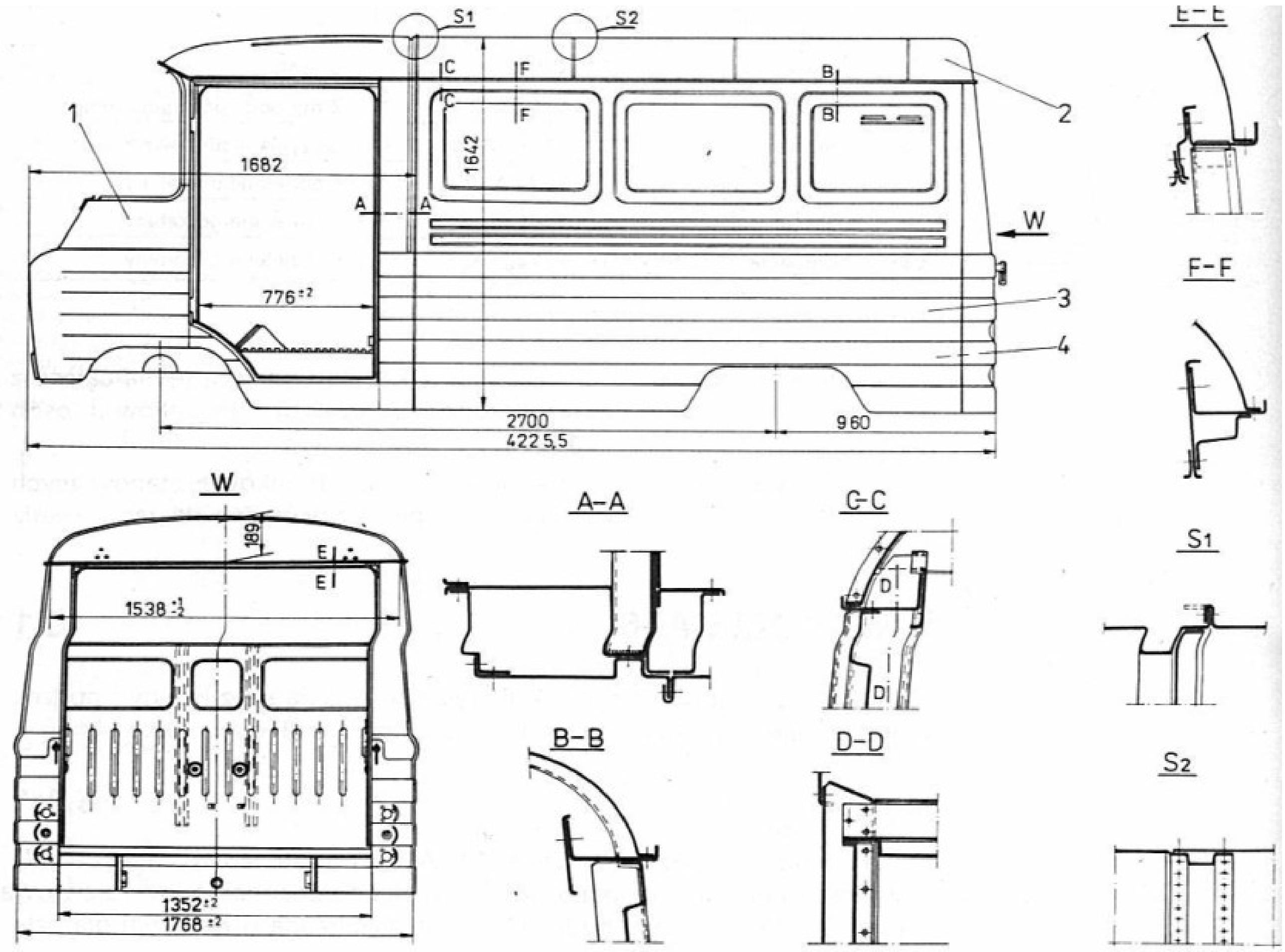
In pickup cars A111, A161 and container cars, e.g. A171, there is used a metal cab, closed, double, double door (Fig.6.3). The cab of the A161 is extended by a compartment for four people, has three side doors, so that together with the driver has room for 6 people. The body of the A06 consists of a cab and a load compartment (Figure 6.4) joined together (in a welding device) by a mechanical connection - wrapping the edges (Section A-A) and spot welding. The side walls of the bodywork compartment A06 do not have windows but stiffenings. The side doors of this bodywork shall have a window with sliding glazing and the rear doors shall have a window with fixed glazing. Ventilation openings are located in the rear wall of the right and left walls. At the bottom of the right wall there is a round hole at the door for the fuel filler pipe in the tank. The interior of the bodywork shall not be covered by an upholstery lining.

Cabin and body elements are joined by spot welding and acetylene welding.

The skeleton made in this way is mounted on door hinges and a cover. The body is then cleaned, degreased, primed and painted. After painting, the windows, electric wires, dashboard, heaters and other accessories are installed and placed on the chassis, on the assembly tape of the car. The cab length (Fig. 6.4) is 1682 mm, width 1768 mm, height 1642 mm and the length of the whole body 4225,5 mm. The body and cabin are bolted to the frame with screws on round steel and rubber washers.

The cab floor is lined with rubber carpets and the interior with upholstery thermal insulation (Fig. 6.6 and 6.34). The window pane of the front cabin is flat, hardened, has the shape of a trapezoid with the dimensions of 640x1372x1432 mm and the thickness of 5 mm (Fig. 6.7). The other windows of the car are also flat and hardened.

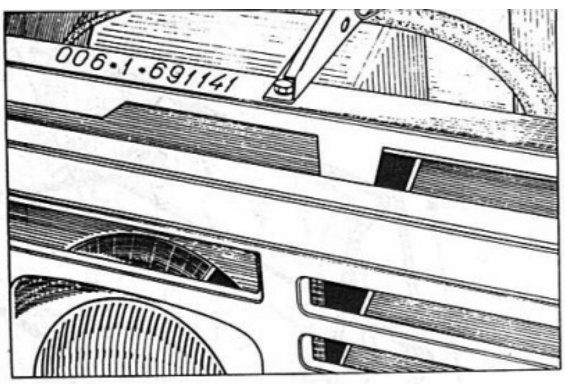
6.1.1 Cabin



6.4. Figure: HOW PANELS OF A06 VANS ARE CONNECTED

1 - cabin, 2 - rear part of roof, 3.4 - side walls

1 - kabina, 2 - część tylna dachu, 3.4 - ściany boczne

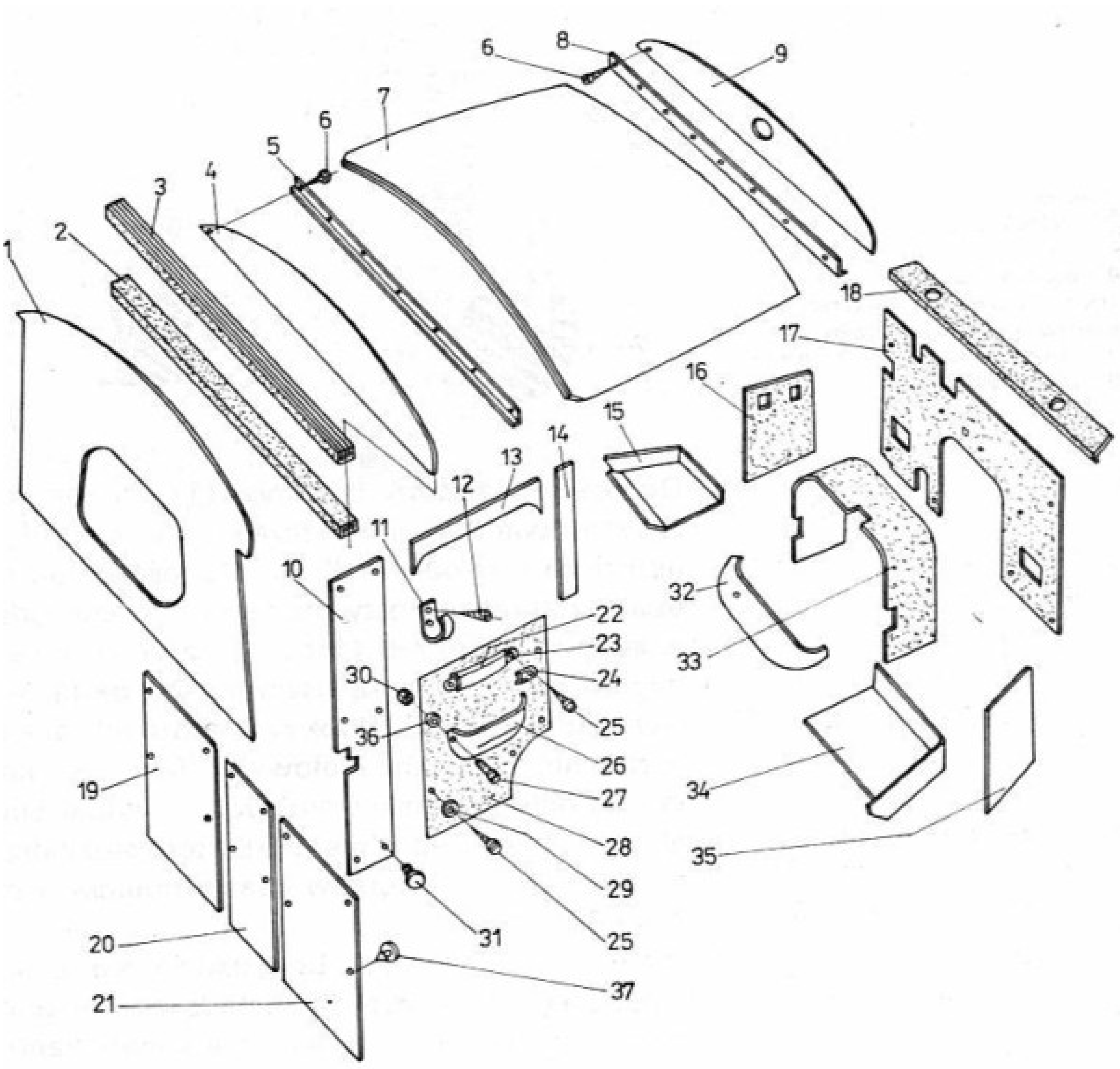


6.5. Figure: BODYWORK NUMBER LOCATION

The numbers in the figure represent:
006 - car body Zuk A06
1 - S-21 motor,
691141 - serial number of the bodywork

Numery podane na rysunku oznaczają:
006 - nadwozie samochodu Zuk A06
1 - silnik S-21,
691141 - kolejny numer fabryczny nadwozia

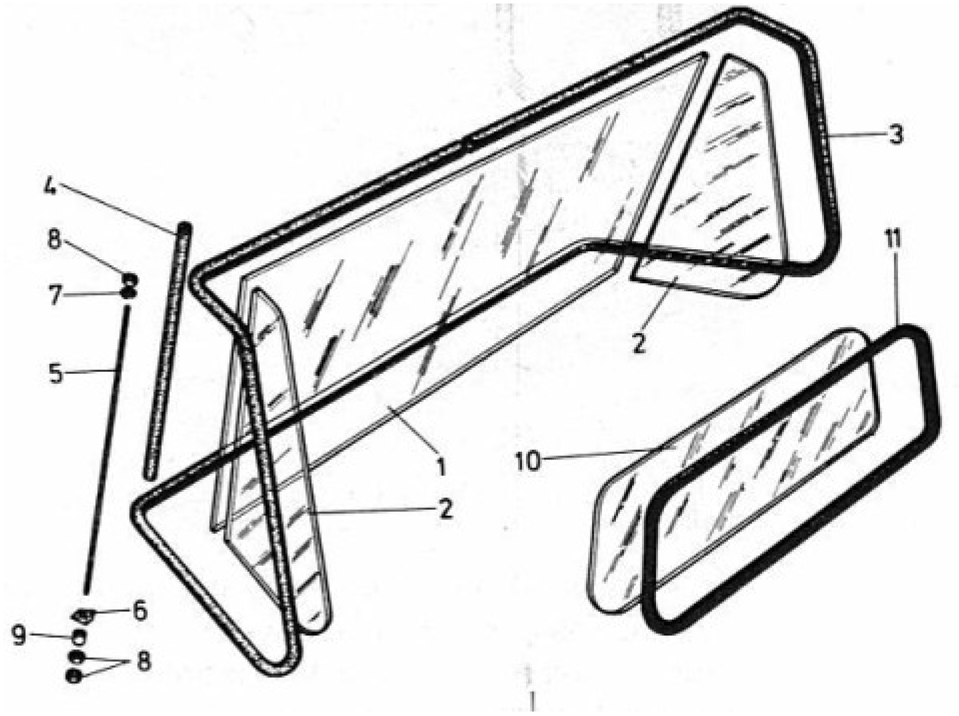
6.1.1 Cabin



6.6. Figure: CABIN INTERNAL COMPONENTS

1 - rear wall sheathing, 2 - partition poster padding, 3 - top poster padding, 4 - cab top wall sheathing. 5 - edging of the top panel of the rear panel. 6 - sheet metal screw, 7 - interior trim of the cab roof, 8 - edge of the top panel of the front panel. 9 - top front plate cover, 10 - rear cab post cover (left), 10 - rear cab post cover (right), 11 - hanger, 12 - sheet metal screw, 13 - front top front cover, 14 - front cab post cover (left), 15 - front cab shelf cover (left). 16 - side wall lining (left), 17 - front wall insulation, 18 - cap, 19 - rear wall lining (left), 20 - rear wall lining (centre), 21 - rear wall lining (right), 22 - handle lining, 23 - handle lining, 24 - handle lining, 25 - sheet metal screwing, 26 - left door pocket, 27 - screw, 28 - door lining (left), 28 - door lining (right), 29 - washer, 30 - nut, 31 - fastener, 32 - rear cover lining, 33 - front cover lining, 34 - front shelf lining (right), 35 - side wall lining (right), 36 - side lining, 37 - fastening button

1 - poszycie ściany tylnej, 2 - nakładka platu przegrody, 3 - nakładka platu górnego, 4 - poszycie płatu górnego ściany tylnej kabiny. 5 - obrzeże poszycia płatu górnego ściany tylnej. 6 - wkręt do blach, 7 - poszycie wewnętrzne dachu kabiny, 8 - obrzeże płatu górnego poszycia przedniego. 9 - poszycie platu górnego przedniego, 10 - nakladka słupka tylnego kabiny (lewa), 10 - nakladka słupka tylnego kabiny (prawa), 11 - wieszak, 12 - wkręt do blach, 13 - nakladka górna przednia, 14 - nakladka słupka przedniego kabiny, 15 - wykładzina półki przedniej (lewa). 16 - wykładzina ściany bocznej (lewa), 17 - wykładzina izolacyjna ściany czołowej, 18 - nakładka, 19 - poszycie ściany tylnej kabiny (lewe) 20 - poszycie ściany tylnej kabiny (środkowe), 21 - poszycie ściany tylnej kabiny (prawe), 22 - osłona uchwytu, 23 - uchwyt, 24 - osłona uchwytu, 25 - wkręt do blach, 26 - kieszeń drzwi lewych, 27 - wkręt, 28 - wykładzina drzwi (lewa), 28 - wykładzina drzwi (prawa), 29 - podkładka, 30 - nakrętka, 31 - spinka, 32 - wykładzina osłony tylnej silnika, 33 - wykładzina osłony przedniej silnika, 34 - wykladzina półki przedniej (prawa), 35 - wykładzina ściany bocznej (prawa), 36 - podkladka, 37 - przycisk mocowania

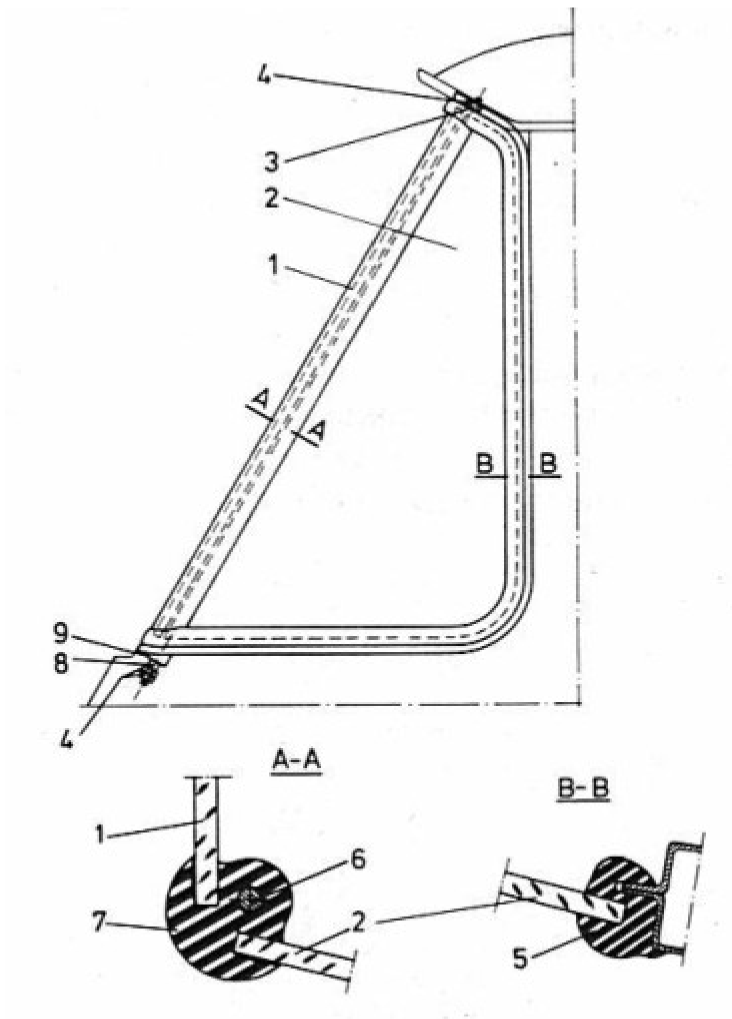


6.7. Figure: FRONT AND REAR WINDOWS

1 - windscreen, 2 - corner glass, 3 - windscreen and corner gasket, 4 - corner gasket, 5 - corner gasket stiffening rod. 6 - wedge washer, 7 - spring washer, 8 - nut (M5), 9 - sleeve, 10 - rear panel glass, 11 - glass gasket

1 - szyba przednia, 2 - szyba narożna, 3 - uszczelka szyby przedniej i narożnych, 4 - uszczelka narożna, 5 - pręt usztywniający uszczelkę narożną. 6 - podkładka klinowa, 7 - podkładka sprężysta, 8 - nakrętka (M5), 9 - tulejka, 10 - szyba ściany tylnej kabiny, 11 - uszczelka szyby

6.1.1 Cabin



1 - windscreen, 2 - corner glass, 3 - spring washer, 4 - nut M5, 5 - corner and windscreen gasket. 6 - Double-sided screw, 7 - glass corner gasket. 8 - sleeve, 9 - wedge-shaped washer

1 - szyba przednia, 2 - szyba narożna, 3 - podkładka sprężysta, 4 - nakrętka M5, 5 - uszczelka szyby narożnej i przedniej. 6 - Śruba dwustronna, 7 - uszczelka narożna szyby. 8 - tulejka, 9 - podkładka klinowa

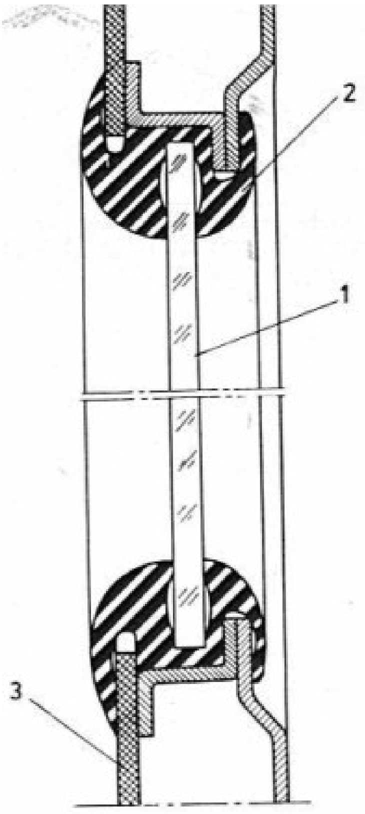
6.8. Figure: INSTALLATION OF THE WINDSCREEN IN THE CABIN

Two 680 mm long corner gaskets (4) and a 5000 mm long circumferential gasket (3) (straight condition) are used to mount the windscreen (1) and corner gasket (2) in the car cab. It is shaped when seated on the edge of the cabin window opening according to the outline of the glass (1 and 2). The gaskets at the corners and at the points of contact between them are sealed with MK paste or sealing mastic (Fig. 6.8). The task of the corner posts is fulfilled by rubber gaskets (7), stiffened with steel rods (6) screwed to the cabin.

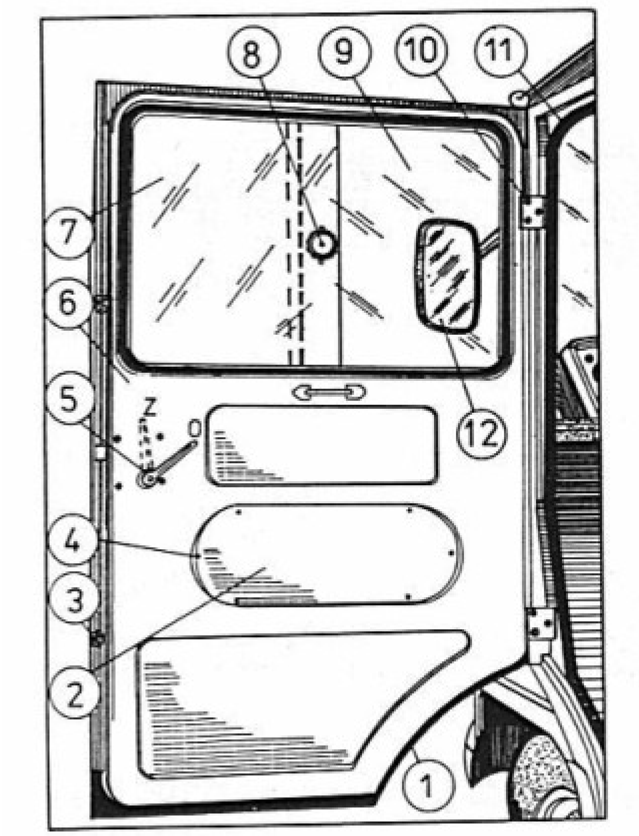
In box cars, in the rear wall of the cabin there is an additional window with a fixed glass pane (Fig. 6.9), which is used to observe the contents of the box and the road while reversing the car. The window has dimensions 777x326 mm.

1 - glass, 2 - gasket, 3 - cab rear wall sheathing

1 - szyba, 2 - uszczelka, 3 - poszycie ściany tylnej kabiny



6.9. Figure: REAR WINDOW OF CAB A11, A16



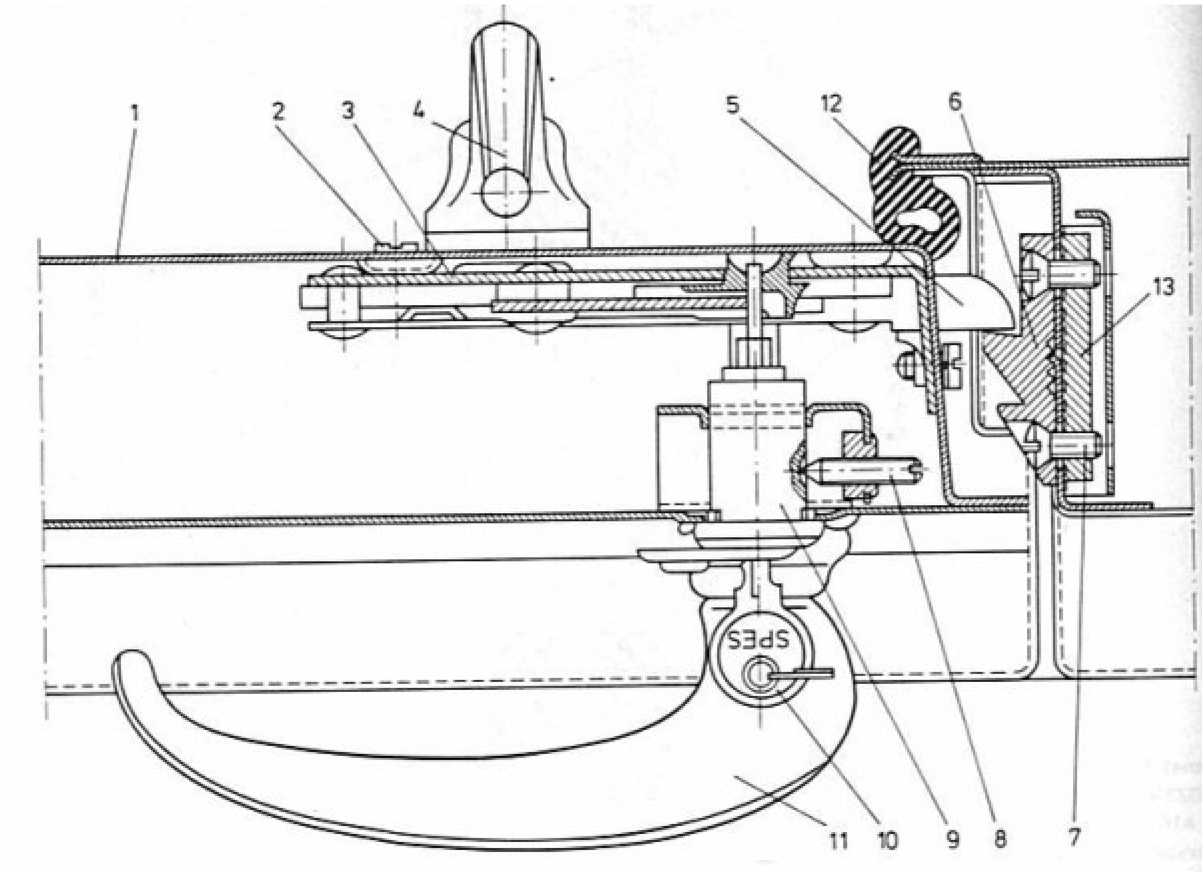
6.10. Figure: LEFT CAB DOOR

1 - bottom seal, 2 - inner cover, 3 - rubber buffer. 4 - screw. 5 - internal handle, 6 - left cab door, 7.9 - sliding glass, 8 - glass locking screw, 10 - hinge, 11 - door gasket. 12 - rear-view mirror 0 - unlocked lock, Z - locked lock

1 - uszczelka dolna, 2 - pokrywa wewnętrzna, 3 - zderzak gumowy. 4 - wkręt. 5 - klamka wewnętrzna, 6 - drzwi kabiny lewe, 7.9 - szyby przesuwne, 8.- śruba ryglowania szyby, 10 - zawiasa, 11 - uszczelka drzwi. 12 - lusterko wsteczne 0 - zamek odryglowany, Z - zamek zaryglowany

Cabin doors (Figure 6.10) consist of an inner and outer shell connected by spot welding all around the perimeter. Before bonding, the inner surfaces of the coverings are covered with a soundproofing paste. The door is hung on hinges (10) screwed to the front posts of the cab. This way of mounting the hinge allows to adjust the position of the door in the cab opening. The door is protected against vibrations while driving with rubber bumpers (3) screwed with two screws. When the cover (2) is unscrewed, the opening in the cover plate allows the door lock to be removed. Cab doors are sealed with rubber seals (1,11).

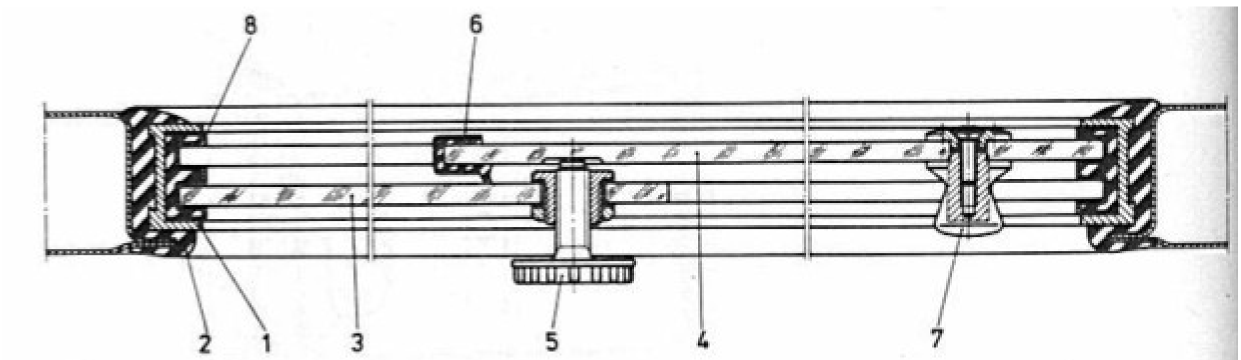
The left and right cabin doors are locked (Fig. 6.11) with the key (10) to the left as far as they will go. To open e.g. the lock of the left cab door, insert the key into the lock hole and turn it clockwise as far as it will go. The left hand door can only be closed properly from outside or inside the vehicle when the inside handle (5, Fig. 6.10) is in the "0" position.



6.11. Figure: LOCK OF THE LEFT CAB DOOR (ZAMEK LEWYCH DRZWI KABINY)

1 - left door, 2 - lock fixing screw, 3 - complete lock, 4 - inner handle (lock lock lock lock), 5 - lock lock lock, 6 - lock striker, 7 - striker screw, 8 - lock cylinder screw, 9 - lock cylinder, 10 - lock key, 11 - outer handle, 12 - door gasket, 13 - sliding plate

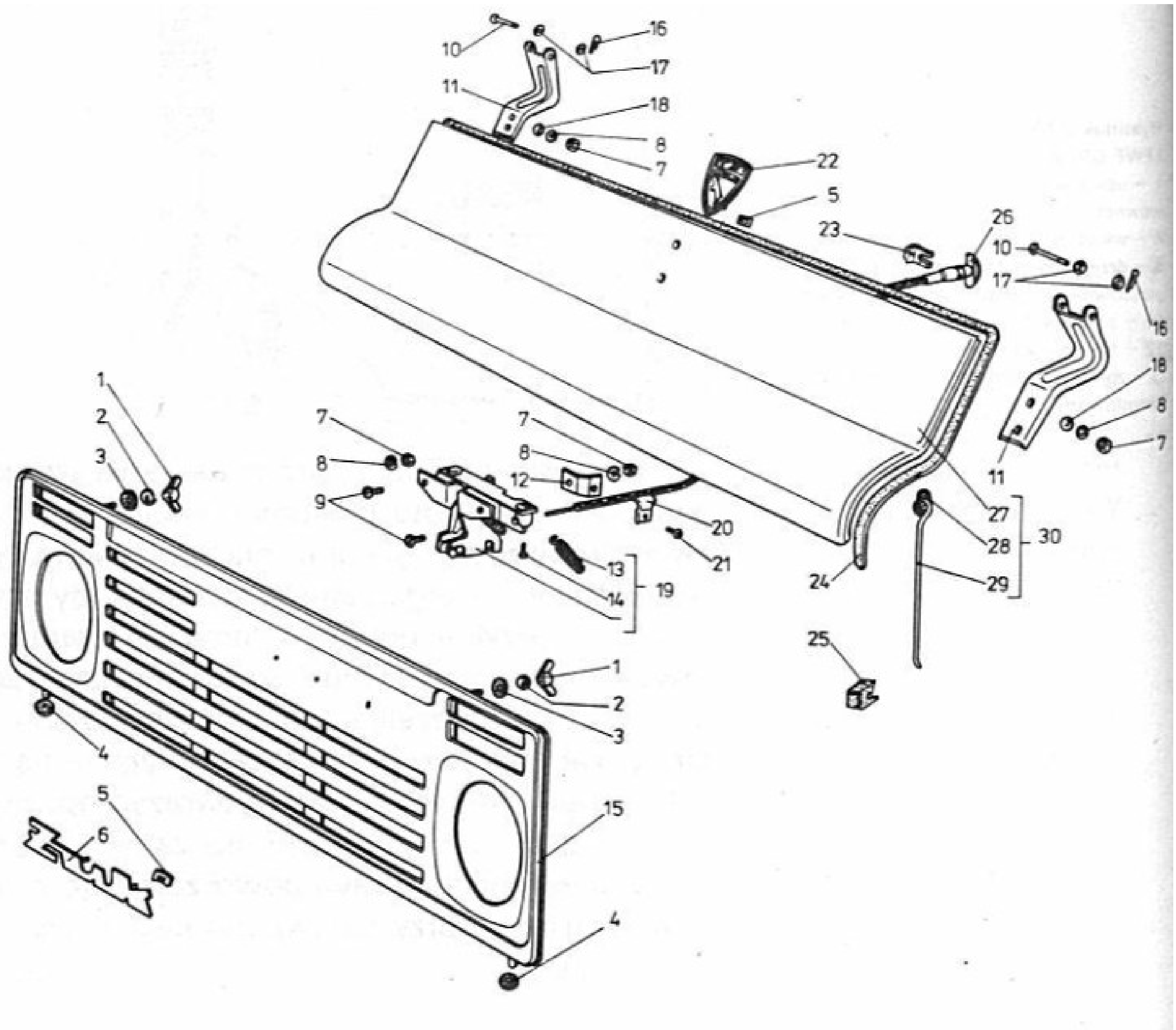
1 - drzwi lewe, 2 - wkręt mocujący zamek, 3 - zamek kompletny, 4 - klamka wewnętrzna (blokada zamka), 5- rygiel zamka, 6 - zaczep rygla, 7 - wkręt zaczepu, 8 - wkręt ryglujący bębenek, 9 - bębenek zamka, 10 - kluczyk zamka, 11 - klamka zewnętrzna, 12 - uszczelka drzwi, 13 - płytka przesuwna



6.12. Figure: CAB DOOR WINDOW (OKNO DRZWI KABINY)

1 - frame, 2 - gasket, 3 - rear window, 4 - windshield, 5 - glass compression screw, 6 - glass trough with gasket. 7 - glass bracket. 8 - glass trough

1 - ramka, 2 - uszczelka, 3 - szyba tylna, 4 - szyba przednia, 5 - śruba dociskowa szyby, 6 - korytko szyby z uszczelką. 7 - uchwyt szyby. 8 - korytko szyby



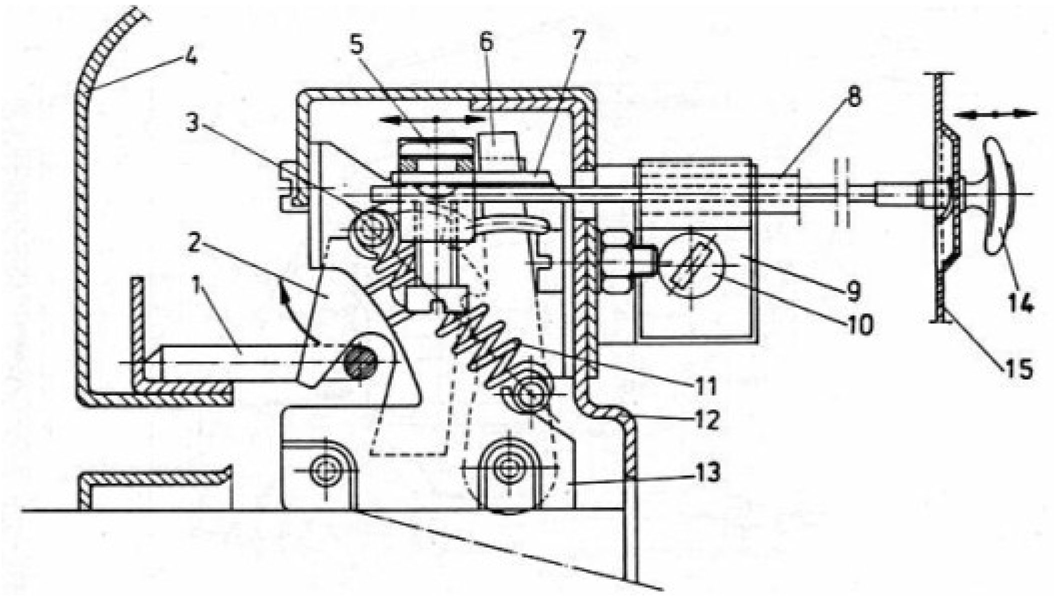
6.13. Figure: CABIN FRONT COVERS (POKRYWY PRZEDNIE KABINY)
1 - nut M8, 2,8 - spring washers, 3 - washer, 4.28 - through-holes, 5 - spring, 6 - sign Zuk", 7 - nut M6, 9 - screw (M6x12). 10 - pin, 11 - hinge, 12 - tendon support, 13 - lock spring, 14 - screw (M4x12). 15 - air inlet cover, 16 - pin, 17, 18 - washers, 19 - zipper, 20 - armouring bracket, 21 - screw (M5x12), 22 - trademark, 23 - spring plate, 24 - gasket, 25 - latch, 26 - complete lock string, 27 - cover, 29 - cover support, 30 - complete front cover.

1 - nakrętka M8, 2,8 - podkładki sprężyste, 3 - podkładka, 4.28 - przelotki, 5 - sprężyna, 6 - znak Zuk", 7- nakrętka M6, 9 - wkręt (M6x12). 10 - sworzeń, 11 - zawiasa, 12 - wspornik cięgna, 13 - sprężyna zamka, 14 - wkręt (M4x12). 15 - osłona wlotu powietrza, 16 - zawleczka, 17, 18 - podkładki, 19 - zamek, 20 - uchwyt pancerza, 21 - wkręt (M5x12), 22 - znak fabryczny, 23 - płytka sprężysta, 24 - uszczelka, 25 - zatrzask, 26 - cięgno zamka kompletne, 27 - pokrywa, 29 - podpora pokrywy, 30 - pokrywa przednia kompletna

The window panes of the cabin door (fig. 6.12) are fitted sliding in a metal frame (1) with a rubber gasket (2). A pressure screw (5) is fitted in the rear sliding glass pane (3) to secure the window panes when closed.

6.1.1 Cabin

The cab front cover (30, Figure 6.13) consists of an extrusion of 0,8 mm thick steel sheet joined together in a circumferential manner by spot welding. It is hung on two special hinges (11), bolted to the inner shell with four screws.



6.14. Figure: THE LOCK OF THE TOP FRONT CAB COVER (ZAMEK POKRYWY GÓRNEJ KABINY)

1 - the cover hook. 2 - lock lock lock, 3-screw (M4x12). 4 - Cab top cover, 5 - Rivet, 6 - Lock lever, 7 - Lock link, 8 - Cord armour, 9 - Cord bracket, 10 - Screw, 11 - Lock spring, 12 - Cabin crossbar, 13 - Lock body, 14 - Lock opening rod handle, 15 - Cab front bulkhead.

1 - zaczep pokrywy. 2 - rygiel zamka, 3-wkręt (M4x12). 4 - pokrywa górna kabiny, 5 - nit, 6 - dźwignia zamka, 7- cięgno zamka, 8 - pancerz cięgna, 9- uchwyt cięgna, 10 - wkręt, 11 - sprężyna rygla, 12 - belka poprzeczna kabiny, 13 - korpus zamka, 14 - rekojeść cięgna otwierania zamka, 15 - przegroda czolowa kabiny

When in the open position, the cover is supported by the support (29). The cover is closed with a special snap-in lock (19). To open the cover (30), pull the cable holder (14, fig. 6.14), located under the dashboard on the right, upwards and support it. Opening the cover allows access to the radiator, water pump, V-belt, heaters, air filter and other engine components. To close the front cover of the cab, press the cable down as far as it will go (14, fig. 6.14) and snap it firmly into place so that the lock lock (2) engages with the cover hook (1). The upper and lateral edges of the cover are sealed with a porous rubber gasket (24, fig. 6.13), glued to the edge of the cover in a duct.

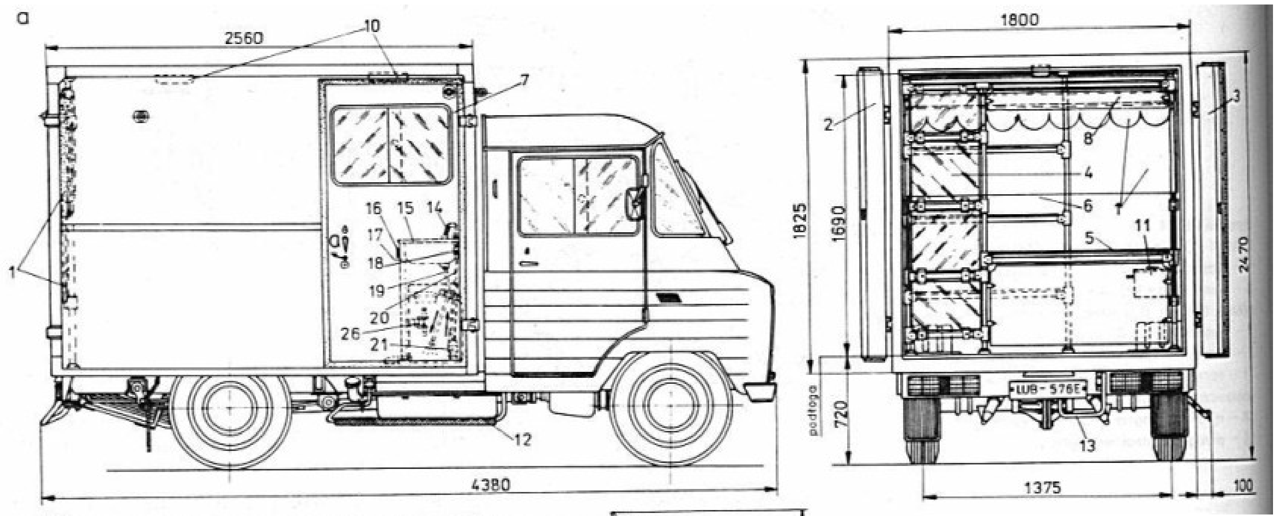
The air inlet cover (15, Fig. 6.13) (dummy) shall be made of 0,8 mm thick steel sheet. It is fixed to the cabin at four points, in the lower part it is mounted on two pivots, placed in sockets with rubber grommets, and in the upper part the mock is screwed to the crossbar of the cabin with two wing nuts.

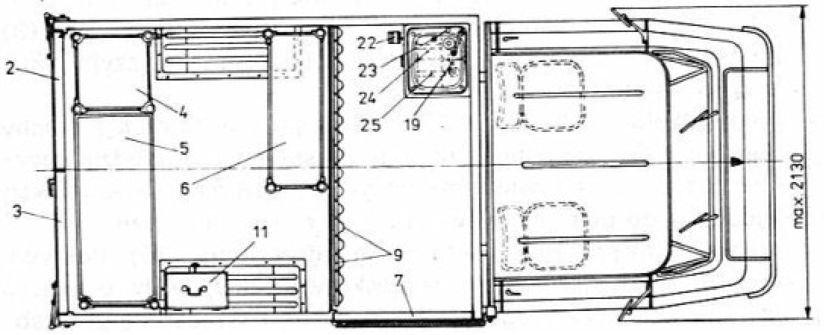
6.1.2 Container bodies

These bodies are mainly designed for the transport of spatial loads, which require protection against atmospheric influences. The walls, roof and rear doors of the body/container are made of steel (Figure 6.15). All bodies have 0.8 mm thick steel sheet walls riveted with special aluminium rivets for steel frames. After assembling and riveting the finished walls and roof in the device, a container

body is obtained. The length of the bodywork shall be 2560 mm, the width 1800 mm and the height 1825 mm. At the corners of the walls, stiffener plates made of thicker steel are used.

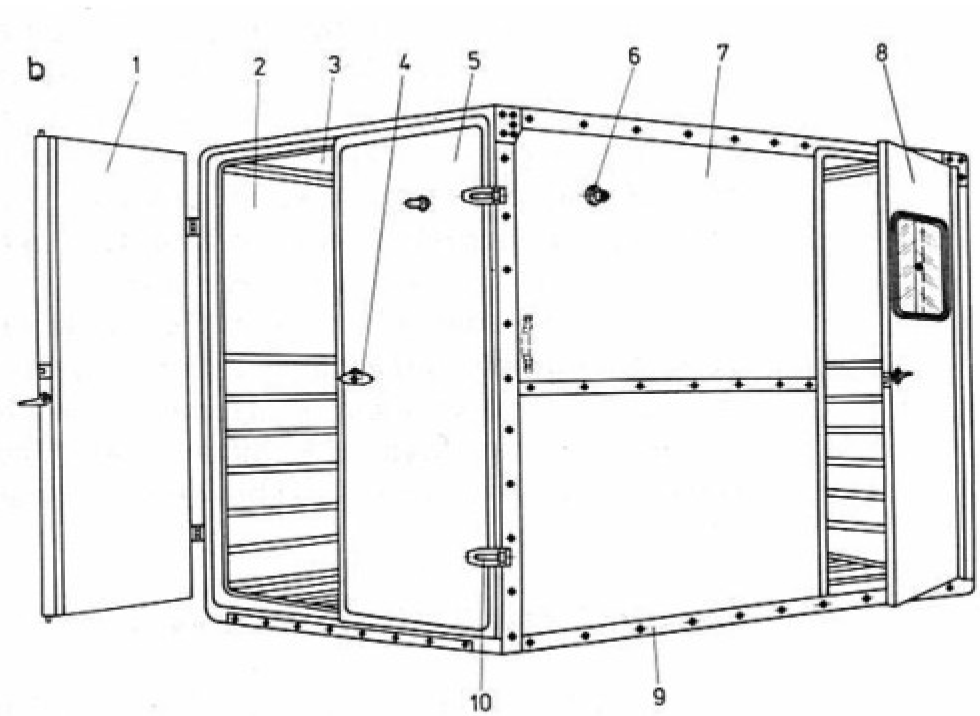
The bodies of the A171 and A172 have double-leaf doors only in the rear wall (without windows), while the bodies of the A173, A174 and A175 also have single-leaf doors with windows in the right side wall.





a - EQUIPMENT OF COMMERCIAL CONTAINER A175
1 - sun screen, 2 - rear door leaf - left, 3 - rear door leaf - right, 4 - small shop shelf, 5 - small counter - counter, 6 - large shop shelf. 7 - side door of container 8 - trade marker. 9 - Extension curtain (backdrop), 10 - Ceiling lamp, 11 - Money cassette, 12 - Side stage, 13 - Back stage, 14 - Mobile tap, 15 - Washbasin, 16 - Pressure screw, 17 - Plate, 18 - Adjusting nut, 19 - Drainage pipe, 20 - Water pipe. 21 - electric water pump. 22 - Pump switch. 23 - basin plug, 24 - canister with water (15 dm^3), 25 - canister with water (15 dm^3). 26 - canister strap
b – CONTENER BODY A171
1 - left rear door leaf, 2 - left wall, 3 - roof, 4 - rear door lock, 5 - right door leaf, 6 - door striker, 7 - right wall, 8 - right wall doors, 9 - container frame, 10 – hinges

a - WYPOSAŻENIE KONTENERA HANDLOWEGO A175
1 - zasłona przeciwsłoneczna, 2 - skrzydło drzwi tylnych - lewe, 3 - skrzydło drzwi tylnych - prawe, 4 - regał sklepowy mały, 5 - lada handlowa - lada, 6 - regał sklepowy duży. 7 - drzwi boczne kontenera 8 - szyld handlowy. 9 - zasłona rozsuwana (kotara), 10 - lampa sufitowa, 11 - kaseta na pieniądze, 12 - stopień boczny, 13 - stopień tylny, 14 - kran ruchomy, 15 - umywalka, 16 - śruba dociskowa, 17 - płyta, 18 - nakrętka regulacyjna, 19 - przewód spustowy, 20 - przewód tłoczący wodę. 21 - elektryczna pompa wody. 22 - włącznik pompy. 23 - korek umywalki, 24 - kanister z wodą (15 dm^3), 25 - kanister na ścieki (15 dm^3). 26 - pasek mocowania kanistrów
b - NADWOZIE KONTENERA A171
1 - skrzydło lewe drzwi tylnych, 2 - ściana lewa, 3 - dach, 4 - zamek drzwi tylnych, 5 - skrzydło prawe drzwi, 6 - zaczep drzwi, 7 - ściana prawa, 8 - drzwi ściany prawej, 9 - rama kontenera, 10 - zawiasa

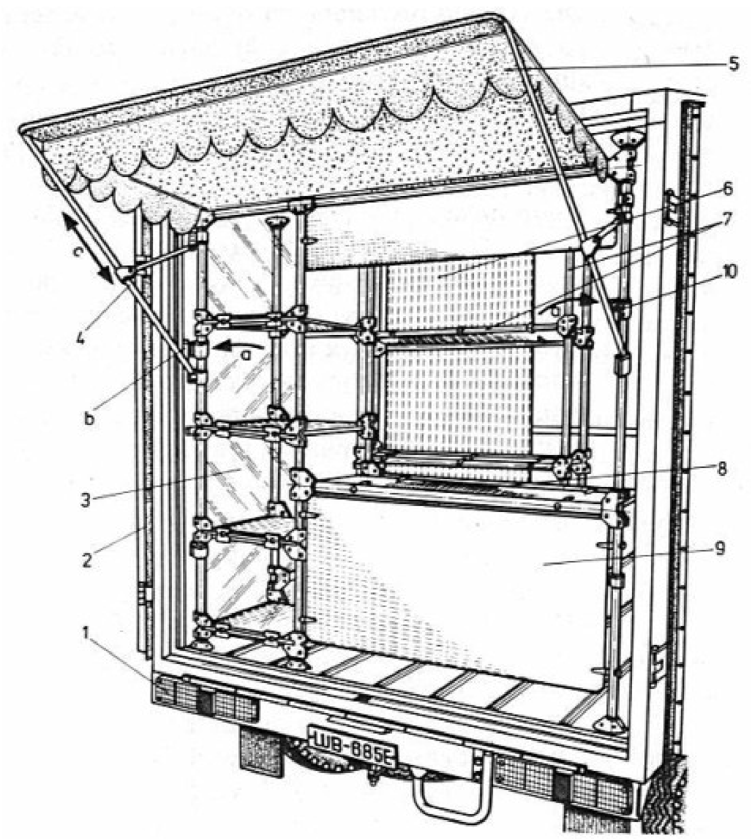


6.15. Figure: CONTAINER BODIES

The body of the A175 commercial container has side walls and ceiling lined with lacquered fibreboards and two shelves (4.6, Figure 6.15a), a commercial counter (5), a curtain (9), a sun screen (1) and a wash basin and water tanks (24, 25).

The fertilizer floor is made of thick (15 mm) plywood, on which a rubber lining is placed, covered with aluminium strips. The rear and side doors are sealed with rubber gaskets all around.

Figure 6.16 shows the interior of the body of a A175 merchant container and how the sun visor is folded out. The curtain (5) consists of a frame made of steel tubes and a waterproof fabric. It is mounted on the rack brackets and on the rear table.



1- composite rear lamps, 2 - left wing of rear door, 3 - large rack. 4-frame for the sun blind. 5- sunshade, 6- curtain, 7- small rack, 8- counter, 9- counter curtain. 10 - lock latch

1- lampy tylne zespolone, 2 - skrzydło lewe drzwi tylnych, 3 - regał duży. 4- ramka zasłony przeciwsłonecznej. 5- zaslona przeciwsłoneczna, 6- kotara, 7 - regał mały, 8 - lada, 9- zaslona lady. 10 - zatrzask blokady

6.16. Figure: INTERIOR OF CONTAINER BODY A175

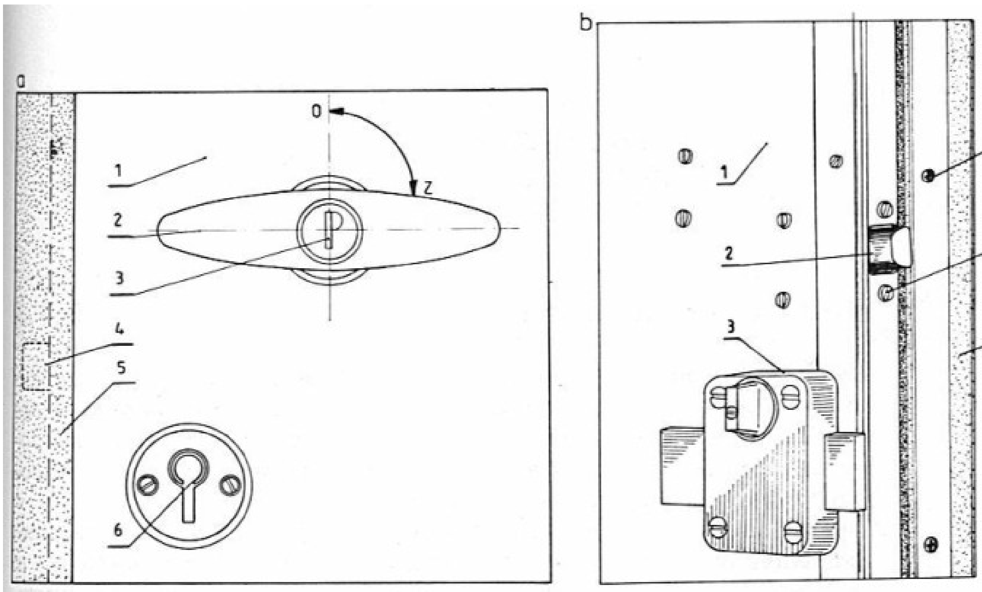
In order to unfold the sunscreen, it is necessary to:

- open the rear door of the bodywork (2),
- remove the locking latch (10) from the curtain frame,
- remove the curtain frame (4) from the locking bracket (10) and slide it upwards in the direction of ½" until it rests against the bracket (10). In this position, lock the cover frame by turning the latch in the direction of "a" until it engages the "b" pin.

The curtain is folded in reverse order, except that to lock the curtain frame, move it in the direction of "a" and then turn the latch (10) clockwise. When unfolding and folding, turn the latch (10) to the right and be careful not to bend the frame or damage the curtain.

6.1.2 Container bodies

The rear door is opened at an angle of 270° and can be locked in this position by means of a pin with a spherical pivot pointing into the rubber seat on the side wall.

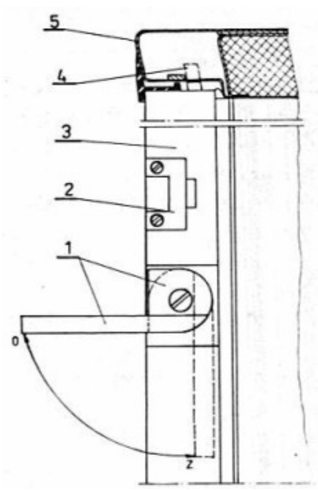


a - opening the door
1 - right hand door leaf,
2 - handle,
3 - lock key,
4 - lock bolt
5 - Door seal,
6 - 'Titanium 140' lock
0 - open,
Z- closed
b- internal view of the lock
1.- right hand door leaf for rear door,
2 - lock bolt
3 - "Titanium 140" lock.
4,5 - screws,
6 - Door seal

a - otwieranie drzwi
1 - skrzydło prawe drzwi,
2 - klamka,
3 - kluczyk zamka,
4 - rygiel zamka,
5 - uszczelka drzwi,
6 - zamek “Tytan 140”
0 - otwarte,
Z- zamknięte
b- widok wewnętrzny zamka
1.- skrzydło prawe drzwi tylnych,
2 - rygiel zamka,
3 - zamek „Tytan 140".
4,5 - wkręty,
6 - uszczelka drzwi

6.17. Figure: LOCKS FOR REAR DOOR OF CONTAINER BODY

The rear door is locked with vertical locks controlled by a handle available when the right leaf is opened. They have one or two locks that can be opened with keys on the outside. To open the rear door of the container body, open the lock (3, Fig. 6.17a) and turn the handle (2) to the "0" position. (open). Then, using the key (6), open the second lock, then turn the lever (1, Fig. 6.18) to the open position (O), open the left door leaf and fasten it on the wall. For the side door (8) of the body the right rear door leaf is used (Fig. 6.15b).



1 - locking lever, 2 - locking clip, 3 - left door leaf, 4 - lock, 5 - container roof 0 - open, Z - closed

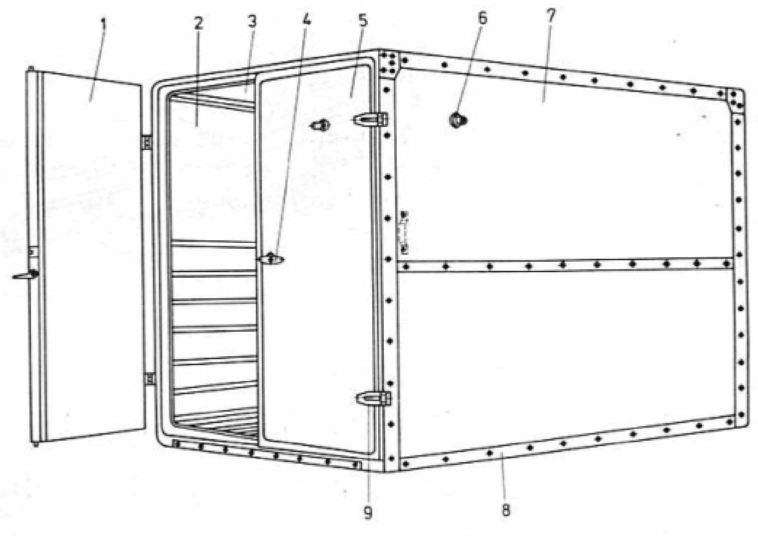
1 - dźwignia mech. ryglowania, 2 - zaczep zamka, 3 - skrzydło lewe drzwi, 4 - rygiel, 5 - dach kontenera 0 - otwarte, Z - zamknięte

6.18. Figure: LOCKING OF CONTAINER DOORS

Repairing damaged walls involves removing aluminium rivets and riveting a new sheet of sheet steel behind the primed one. The inserted wall panel should then be painted with two layers of enamel in the colour of the body.

6.1.3 Isothermal bodies

The external dimensions of these bodies (Figure 6.19) are the same as those of the container bodies. The exterior cladding of the walls and roof of the body is made of 0,9 mm steel sheet and the interior cladding is made of 1 mm anodised aluminium sheet. The walls and roof are connected with special aluminium rivets in the assembly device.



1 - left door leaf, 2 - right wall, 3 - roof, 4 - lock, 5 - right door leaf, 6 - door striker, 7 - right wall, 8 - wall frame. 9 - rear door hinge

1 - skrzydło lewe drzwi, 2 - ściana prawa, 3 - dach, 4 - zamek, 5 - skrzydlo prawe drzwi, 6 - zaczep drzwi, 7 - ściana prawa, 8 - rama ściany. 9 - zawiasa drzwi tylnych

6.19. Figure: ISOTHERMAL BODY A17

The interior of the body walls is filled with rigid polyurethane foam and injection moulding. The wall thickness in the assembly is 60 mm. This bodywork shall be leak-proof and non-combustible. The joints of the coverings are sealed with autoclave and the door openings are sealed with rubber gaskets all over the water. The floor of the body is made of 15 mm thick plywood on which is placed an aluminum sheet screwed with screws. N: the body side walls are screwed in from the inside with wooden protective strips.

The isothermal chamber provides a high temperature stability for the food products transported, depending on:

- the nature of the products transported,
- the cooling of the products during loading,
- the quantities of products loaded,
- external temperature (air),
- the driving time,
- the frequency of door opening of the isothermal chamber.

Internal wall coverings and the body floor shall be protected against damage during operation. When transporting heavy and hard loads (crates, drums) with food products, they must always be arranged in such a way that they do not move while driving.

Cleaning and maintenance of the isothermal body. The interior of the isothermal body shall be kept absolutely clean. Use hot water with the addition of cleaning and disinfecting agents for

cleaning. The body can be washed by hand with brushes, rags or a special brush with a low pressure water supply.

When cleaning, position the car backwards on a slight slope so that water flows from the floor of the car body.

The body after washing with cleaning agents should be rinsed with clean water, thoroughly wiped out and dried, paying special attention to drying the door niche.

In order to ensure that the quality of the products transported does not deteriorate, it is necessary to ventilate the interior of the body as often as possible by opening the rear door, especially after the transport of products with an intense smell.

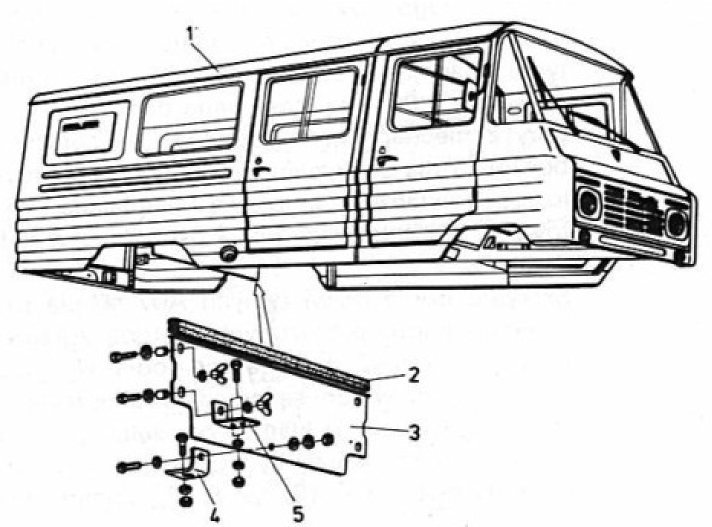
Door locks and hinges should be lubricated every 2 to 3 months with INHIBOL protective oil or graphite powder.

Isothermal bodies shall be repaired in a manner similar to that of container bodies (Chapter 6.1.1).

6.2 BODIES FOR THE CARRIAGE OF GOODS AND PASSENGERS

6.2.1 Body A07

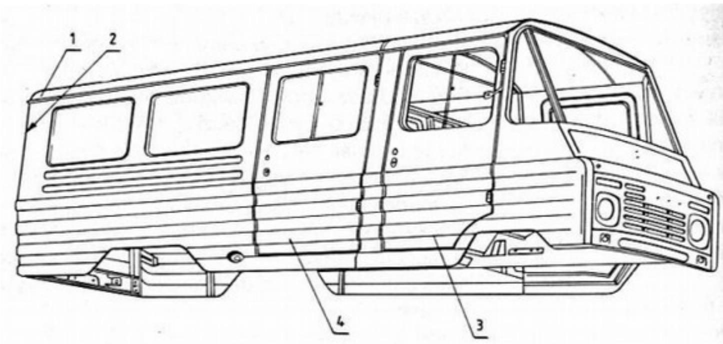
The bodies of these cars (Fig. 6.20) consist of the driver's cab and the passenger compartment. The method of connection of the walls and the cab to the load compartment of these bodies shall be as shown in Figure 6.4. The walls of the cab and the bodywork, the roof and the doors shall be of 0,9 mm thick steel sheet.



1 - bodywork, 2 - partition casing. 3 - sheet metal partition, 4 - bracket for fixing the partition. 5 - partition bracket

1 - nadwozie, 2 - osłona przegrody. 3 - przegroda blaszana, 4 - wspornik mocowania przegrody. 5 - uchwyt przegrody

6.20. Figure: BODY A07



1 - body roof, 2 rear doors. 3 - cab side doors. 4 - passenger compartment door

1 - dach nadwozia, 2 drzwi tylne. 3 - drzwi boczne kabiny. 4 - drzwi przedziału pasażerskiego

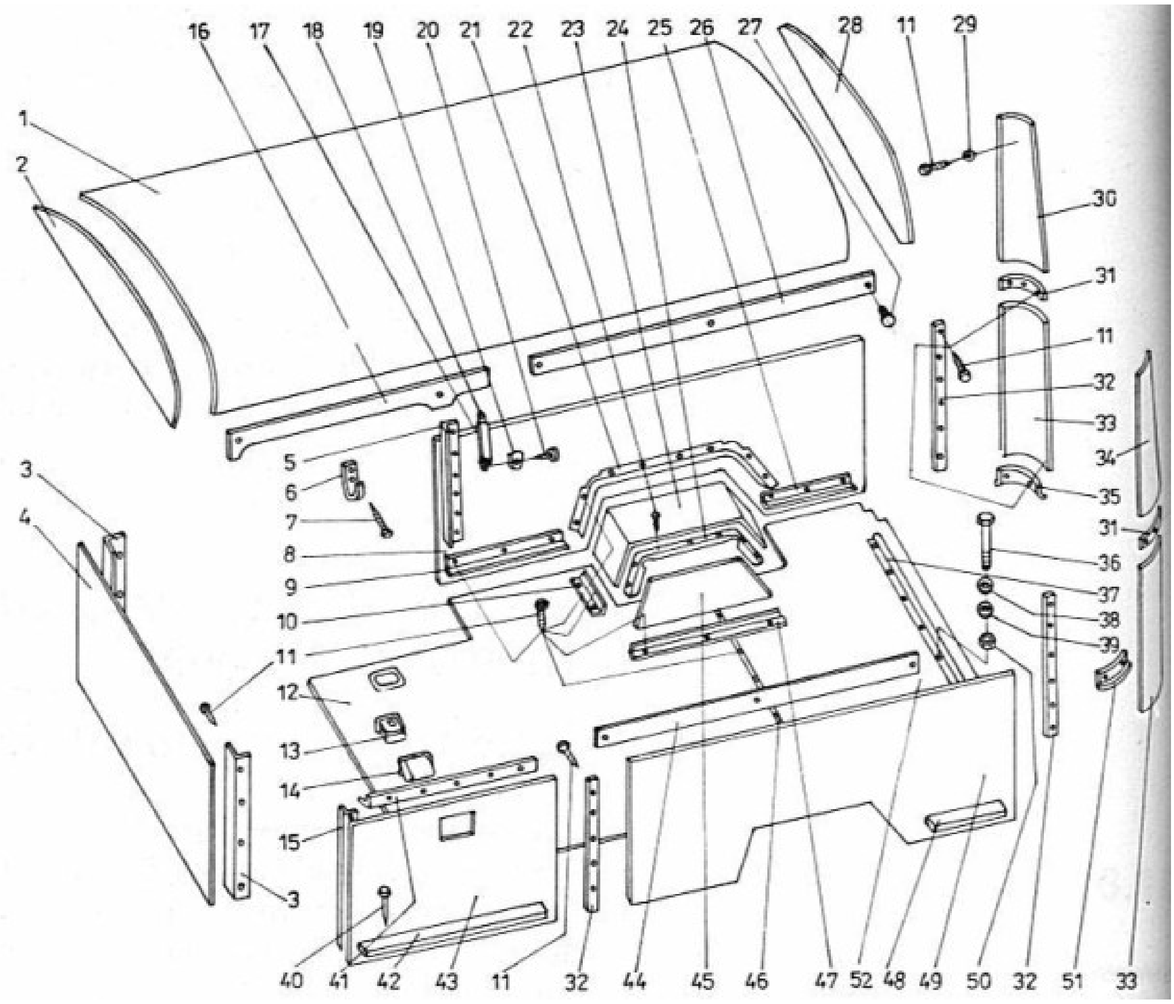
6.20a. Figure: BODY MICROBUS A18

The sides of the cargo compartment consist of a frame and an outer shell. The frame and the cover are spot welded. The roof consists of five extrusions. In the right wall there is a side door. The rear door consists of an upper and a lower leaf. The body of the A18 minibus (Figure 6.20a) uses a one-piece, upward opening rear door with gas spring support. Windows shall be used in the side walls of the passenger compartment. The interior is lined with insulating upholstery (Fig. 6.20b). They are equipped with air seats for 7 people (+ 2 in the cabin) and an additional heater.

The upper door leaf of the rear door A07 consists of an outer and inner shell, connected by spot welding. It is hung on two hinges (forgings) screwed to the roof supports. Rubber gaskets are used in doors. At the bottom of the sash there is a lock with an outer handle (Fig. 6.21).

The top leaf can be supported in the open position with a scissor support (2, fig. 6.22). The upper door leaf lock is locked with a key.

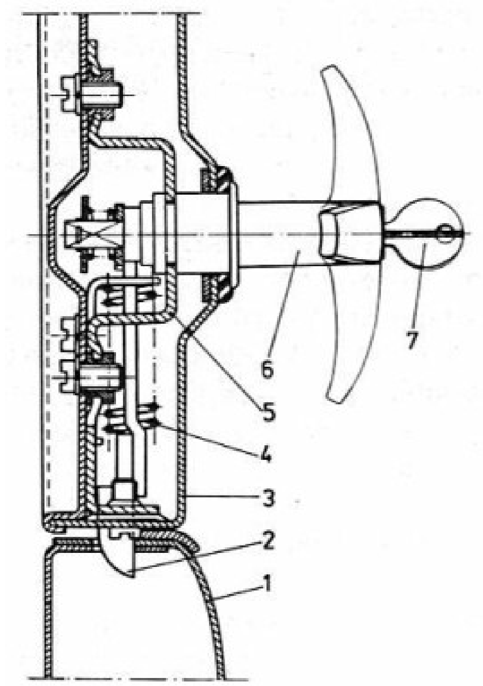
6.2.1 Body A07



6.20a. Figure: INTERIOR LINING OF BODIES A07 AND A18

1 - headliner, 2 - topplate covering (backplate), 3 - carpet trim, 4 - cab partition trim (bottomplate), 5 - front carpet trim, 6 - hanger, 7. 11 - sheet metal screws 3,9x19,8 - side wall lining (rearplate right), 9 - side wall lining (rearplate left). 10 - pressure strip, 12 - front floor covering, 13 - ashtray. 14 - ashtray frame, 15 - ashtray for front (left) carpet. 16 - top cap, 17. 19 - handle cover, 18 - handle, 20 - sheet metal screw 3,9x13, 21 - mudguard lining strip, 22 - sheet metal screw 3.9x16, 23 - mudguard lining (top). 24 - pressure strip, 25 - carpet fixing strip (rear bottom), 26 - window overlay (right). 27 - fastening, 28 - soffit (rear part), 29 - padding, 30 - carpet for rear corner (upper right), 31 - carpet strip for corner, 32 - carpet strip (rear part). 33 - rear corner lining (bottom). 34 - rear corner lining (upper left). 35 - carpet trim (bottom right), 36 - screw M6x40, 37 - carpet trim (bottom right), 36 - screw M6x40, 37 - carpet trim (bottom right), 38 - padding A6.6. 39 - padding of 6.1. 40 - nailing 2.0x50, 41 - padding strip (front), 42 - padding for floor (front), 43 - padding for left side wall, 44 - padding for left side, 45 - padding for left side, 46, 47 - padding for side mudguard, 48 - padding for left side wall, 49 - padding for left side wall. 50 - nut M6. 51 - corner lining trim, 52 - rear lining

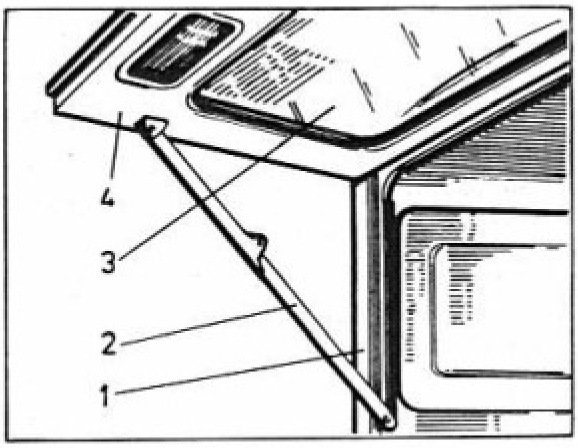
1 - podsufitka, 2 - poszycie platu górnego (tylne), 3 - listwa wykładziny, 4 - wykałdzina przegrody kabiny (część dolna), 5 - listwa wykładziny przednia, 6 - wieszak, 7. 11 - wkręty do blach 3,9x19,8 - wykładzina ściany bocznej (cześć tylna prawa), 9 - wykładzina ściany bocznej (część tylna lewa). 10 - listwa dociskowa, 12 - wykładzina podłogi przednia, 13 - popielniczka. 14 - ramka popielniczki, 15 - listwa wykładziny przednia (lewa). 16 - nakładka górna, 17. 19 - osłona uchwytu, 18 - uchwyt, 20 - wkręt do blach 3,9x13, 21 - listwa wykładziny błotnika, 22 - wkręt do blach 3.9x16, 23 - wykładzina błotnika (górna). 24 - listwa dociskowa, 25 - listwa mocowania wykładziny (dolna tylna), 26 - nakładka nadokienna (prawa). 27 - spinka, 28 - podsufitka (część tylna), 29 - podkladka, 30 - wykładzina narożnika tylnego (górna prawa), 31 - listwa wykładziny narożnika, 32 - listwa wykładziny (tylna). 33 - wykładzina narożnika tylnego (dolna). 34 - wykładzina narożnika tylnego (górna lewa). 35 - listwa wykładziny (dolna prawa), 36 - śruba M6x40, 37 - listwa, 38 - podkladka A6,6. 39 - podkładka z 6,1. 40 - gwóźdź 2,0x50, 41 - listwa wykładziny (przednia), 42 - nakladka podłogi (przednia), 43 - wykładzina ściany bocznej lewej, 44 - nakładka nadokienna (lewa), 45 - wykładzina błotnika boczna, 46, 47 - listwy dociskowe, 48 - nakładka podłogi tylna, 49 - wykładzina ściany bocznej lewej. 50 - nakrętka M6. 51 - listwa wykładziny narożnika, 52 - wykładzina podłogi tylna



6.21. Figure: A07 REAR DOOR LOCK

1,3 - bottom and top door leaves, 2 - lock bolt, 4 - lock spring, 5 - lock, 6 - handle, 7 – key.

1,3 - skrzydła drzwi dolne i górne, 2 - rygiel zamka, 4 - sprężyna rygla, 5- zamek, 6 - klamka, 7 - kluczyk



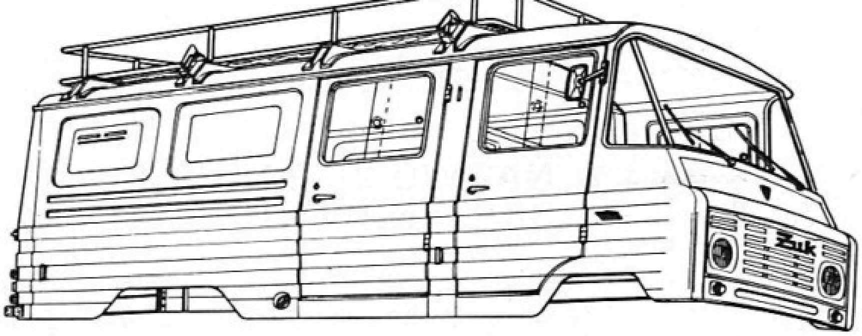
6.22. Figure: SUPPORT FOR THE UPPER DOOR LEAF OF THE REAR VAN AND THE GOODS DOOR

1 - left wall of the body, 2 - scissor support, 3 - upper wing glass. 4- upper sash

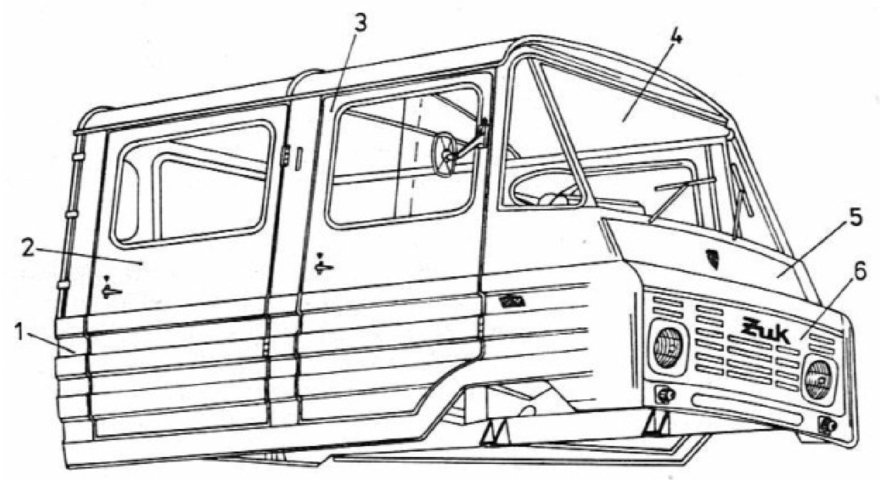
1 - ściana lewa nadwozia, 2 - podpora nożycowa, 3 - szyba skrzydła górnego. 4- skrzydlo górne

6.2.2 Specialist van body

On the basis of the body of the A06 and A07 vans, further variants of vans are manufactured: The body A072 is designed to carry assembly teams and can also be used for cars in emergency power, gas, water and sewage, agriculture or tourism. It can carry up to 9 people including the driver and installation equipment.



6.23. Figure: VAN BODY A061 WITH ROOF RACK



1 - right wall, 2 - cab access door, 3 - right cab door. 4- cab windscreen, 5 - cab top cover, 6 - air inlet cover

1 - ściana prawa, 2 - drzwi dodatkowe kabiny, 3 - prawe drzwi kabiny. 4- przednia szyba kabiny, 5 - górna pokrywa kabiny, 6 - oslona wlotu powietrza

6.24. Figure: BOX CAR A161

A 2644 x 1200 x 200 mm rack is mounted on the roof of the body for the carriage of light loads. Behind the cabin partition there is a passenger compartment with three folding benches for 7 persons. The passenger compartment is heated by an additional heating element and a ceiling lamp is illuminated.

Behind a passenger compartment which is separated by a partition bolted to the chassis by bolts, there shall be a luggage compartment for the carriage of goods. There shall be two side windows in the passenger compartment. A window shall not be used for the rear door. The cabin and passenger compartment are glued with upholstery. An access step shall be used for easier access to the passenger compartment. Access to the roof rack is facilitated by two folding side steps to the right of the vehicle.

Specialist body A062

This body has a heated compartment behind the driver's cabin, in which two benches for escorts are installed by an additional wall, separating the cargo space from the space of escorts, and a folding table. One of the benches is fixed and the other is foldable. This room has two windows in the side walls. Behind the convoy room there is a separate loading room, whose roof, floor and side walls are made as double walls (two layers of metal sheet).

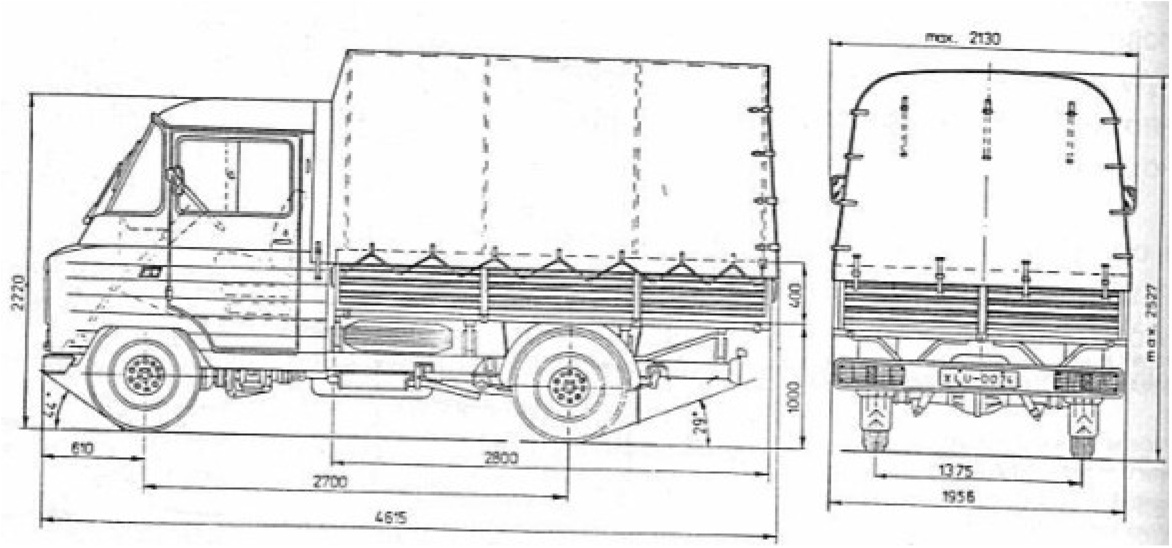
The interior of the vehicle shall be illuminated by two ceiling lamps The rear wall of the bodywork shall have neither a door nor a window. A ventilator is installed in the escort room roof. The driver's cab and compartment are glued with upholstery. An entrance step is built into the escort compartment at the entrance door.

The car is equipped with an alarm system and an ignition lock. It is designed for transporting valuable shipments.

6.3 PICKUP BODIES A111 and A161

6.3 PICKUP BODIES A111 and A161

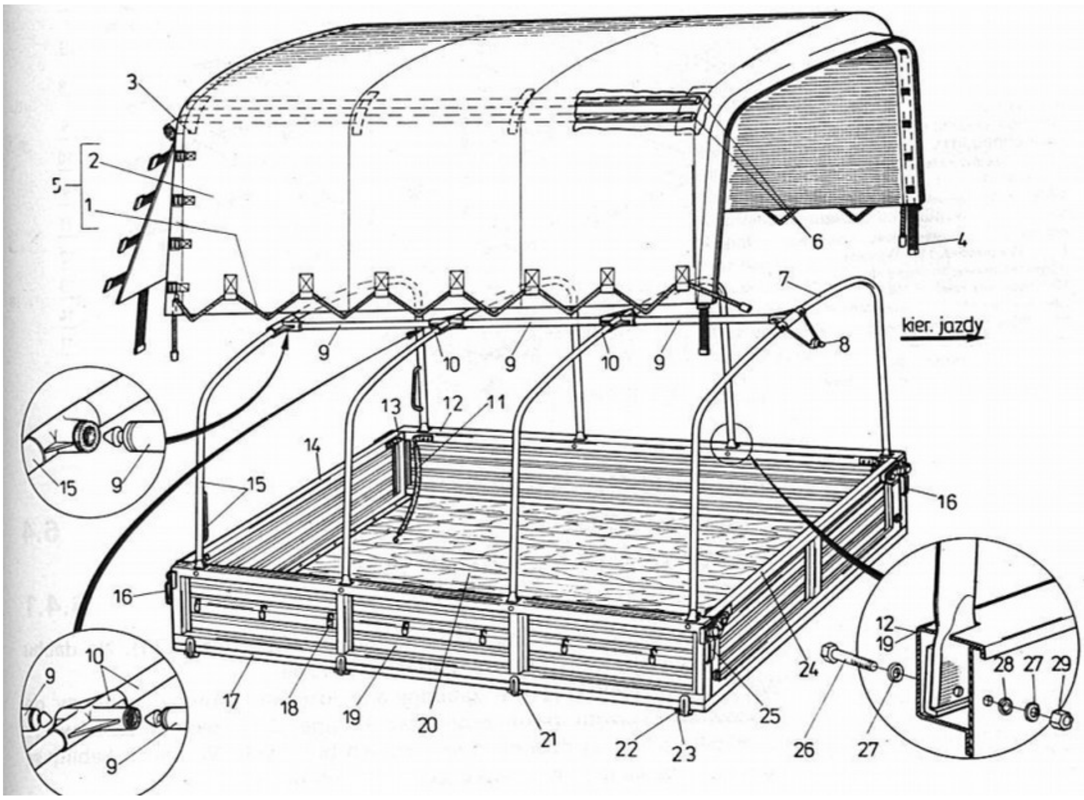
The main components of the body of these vehicles are the driver's cab, the load platform, the bars and the sheet. Figure 6.25 shows a car with an A111 metal box.



6.25. Figure: BODY A111

6.3.1 Cargo box and sheet A111

The A111 has a larger metal box (used from the "Lublin" car) and a wooden floor. The A161 has an extended cabin for 6 people (including the driver) and a shortened load platform. Box cars are mostly manufactured with arches and a tarpaulin sheet.



6.26. Figure: CARGO PLATFORM, BOGIES AND CURTAINS A111

1 - cord, 2 - sheet, 3 - strip socket, 4 - belt, 5 - complete sheet, 6 - strips. 7 - front handle, 8 - burner connector with cab. 9 - pelak union, 10 - centre beam. 11 - support chain. 12, 19 - side wall, 13 - chain hook, 14 - rear wall, 15 - rear bow, 16 - left load carrier lock, 17 - floor frame, 18 - rope hook, 20 - floor, 21 - hinges. 22 - pin, 23 - round pad. 24 - front wall, 25 - right hand side lockable load platform. 26 - bolt M6x40.27 - pad, 28 - washer, 29 - nut M6

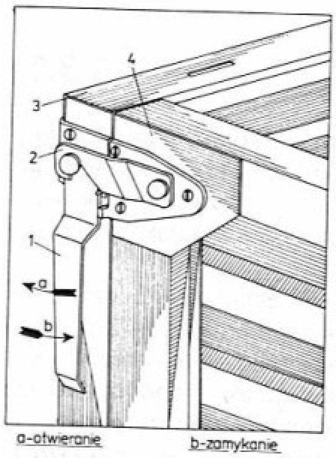
1 - sznur, 2 - opończa, 3 - gniazdo listwy, 4 - pas, 5 - opończa kompletna, 6 - listwy. 7 - pałąk przedni, 8 - łącznik palaka z kabiną. 9 - łącznik pelaków, 10 - pałąk środkowy. 11 - łańcuch podtrzymujący. 12, 19 - ściana boczna, 13 - zaczep lancucha, 14 - ściana tylna, 15 - pałąk tylny, 16 - zamek skrzyni ładunkowej lewy, 17 - rama podłogi, 18 - zaczep sznura, 20 - podłoga, 21 - zawiasa. 22 - zawleczka, 23 - podkladka okrągła. 24 - ściana przednia, 25 - zamek skrzyni ładunkowej prawy. 26 - śruba M6x40.27 - podkladka, 28 - podkładka sprężysta, 29 - nakrętka M6

The load platform of the A111 (Figure 6.26) consists of four walls, namely two side walls (12,19), the front wall (24) and the rear wall (14) made of corrugated steel sheet and wooden floor (20). On this box are used arches and curtains, and quick-mounting wall hooks in each corner. The sheet shall be supported by four wooden battens. The walls of box A111 shall be hinged to the floor and may be lowered or hung by chains, with the sheet used lowered to the rear only (14).

For example, to open the rear panel of the A111 load platform, the safety hooks and the locking tabs must be removed from both sides.

When loading heavy loads, be careful not to damage the load platform walls during operation.

If the floor is damaged, remove the damaged board, insert a new one and paint it. The slightly curved walls of the A111 metal box can be straightened and the holes repaired by cutting out the batten and welding it on, priming it and painting it with enamel of the correct colour.



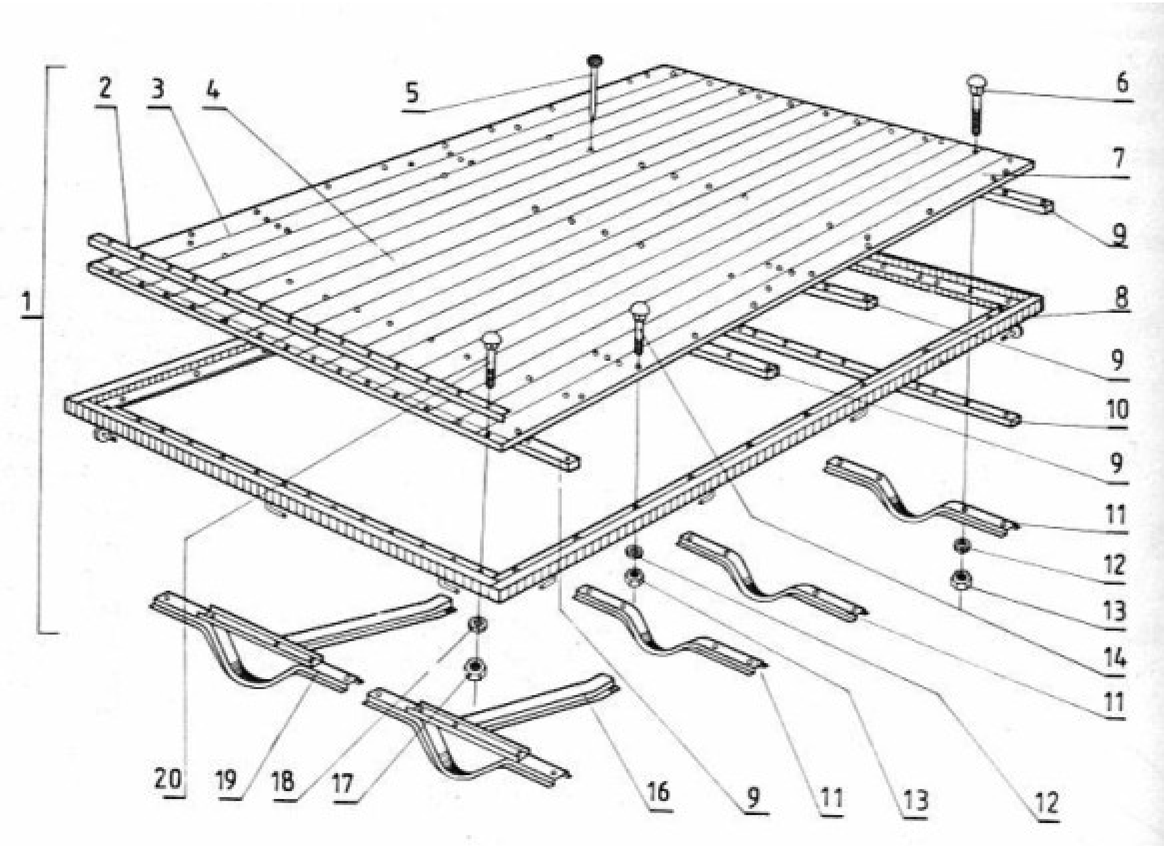
6.27. Figure: ZUK CARGO BOX LOCK

The length of the loading area of the A111 is 2800 mm and that of the A161 is 1820 mm. The width of the loading platforms of these vehicles is 1956 mm, the height is 400 mm (Fig. 6.25). The side panels and the rear panels of the load platform are opened so that the materials transported can be loaded and unloaded easily and in a mechanised manner. To open the box, the safety hooks must be removed from both sides (fig. 6.27).

6.3.2 Cargo platform floor A111 and A161

The floor of the box car (Fig. 6.28) is made of pine impregnated boards. The chassis is a metal frame (8) and secured with M8x75 screws to the load carrier brackets (11, 16, 19) attached to the car frame. The floor boards (4) are nailed to the wood beams by the nails (2 x 50) (9.15). This floor is used in the new Lublin 3352 box car and when loading goods, e.g. barrels, crates, you should be careful not to damage the floor. Always keep the floor clean, wash it periodically with water and and wipe it dry. Remove the damaged knot from the floor, insert a new knot and paint it.

6.3.2 Cargo platform floor A111 and A161



6.28. Figure: LOAD PLATFORM FLOOR OF CAR A111

1 - Cargo platform floor, 2 - Slatted, 3 - Left board, 4 - Mid board, 5 - Nail 2x50, 6 - Screw M8x75, 7 - Right board, 8 - Squirt flooring, 9 - Floor beam. 10 - Front beam, 11 - Carrier bracket midplate, 12 - Elastic washer 28.2. 13 - Nut M8, 14 - Screw M8x35. 16 - Bracket with splice connector. - Right, 17 - nut M6, 18 - washer 26,1. 19 - bracket with coupling ppl. - Left. 20 - Screw M6x35

1 - Podloga skrzyni ładunkowej, 2 - Listwa, 3 - Deska lewa, 4 - Deska środkowa, 5 - Gwóźdź 2x50, 6 - Sruba M8x75, 7 - Deska prawa, 8 - Obrzeże podłogi kpl., 9 - Belka podłogi. 10 - Belka przednia, 11 - Wspornik skrzyni ładunkowej środkowy kpl., 12 - Podkładka sprężysta 28.2. 13 - Nakrętka M8, 14 - Sruba M8x35. 16 - Wspornik z lącznikiem kpl. - prawy, 17 - Nakrętka M6, 18 - Podkładka sprężysta 26,1. 19 - Wspornik z łącznikiem kpl. - lewy. 20 - Sruba M6x35

6.4 FIRE TRUCK VEHICLE BODIES (todo)

6.5 BODYWORK LACQUER COATING

6.5.1 Factory painting

In the production process of cabins and bodies, modern corrosion protection is applied in the following way:

- alkaline spray degreasing extrusion before welding,
- alkaline spray degreasing of cabins and bodies (after welding) on painting tape,
- electrophoretic immersion priming with water-borne epoxyester paint (ICI) beige, symbol 6223-398-480 according to ZN-76/MPCh-Fl-122,
- spray primer with a phthalic primer that does not require sanding, "22", dries at 80°C, yellow, KTM 1313-1328-5350-500,
- spraying with phthalic enamel dries in the oven at 80°C for 60 minutes (Ref. No. KTM 1313-463-818-605 WT-1/87 according to ZN-84/MPCh and L-TF-3309).

The thickness of the coating obtained from the two layers of primer and one layer of topcoat enamel is 80... 100 µm.

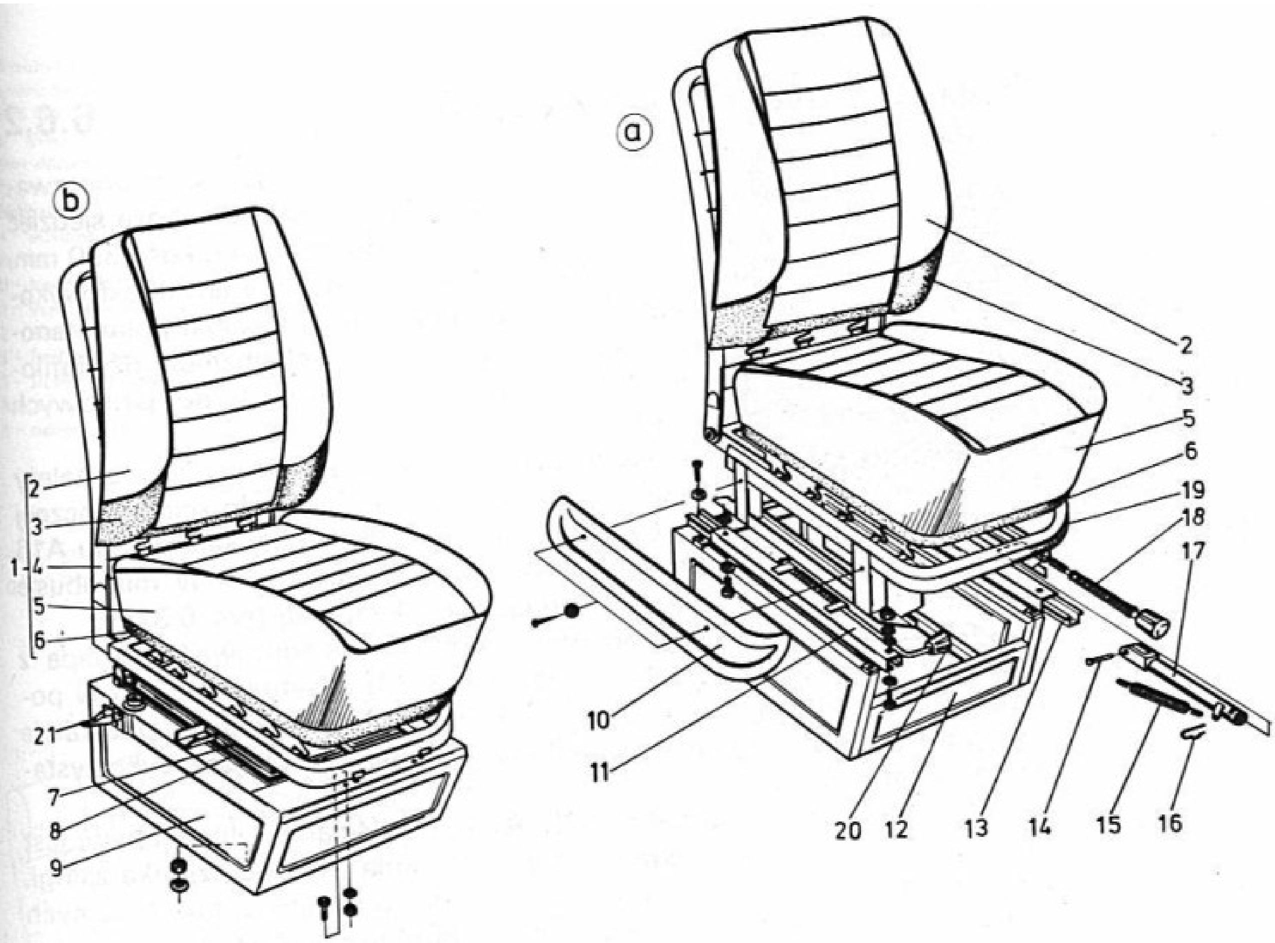
Lacquering treatments on the bodywork may only be carried out with enamel of the same type (nitro enamel is not recommended). Cab roof connections (gutters) and the floor are covered with "sound absorbing phthalic mass PG-174" SWW 3143-466-990, the following place of connecting the sheets is sealed on the whole length with "Autocit" SWW 4373-99 according to ZN-78/MPCh-G/K22:

- footrest with a front arch,
- footrest with a floor plate,
- footrest with faceplate,
- faceplate with side panel,
- roof with a window beam,
- roof with a side wall,
- floor with a rear wall of the cab.

The method of repainting the bodywork, which is used after the bodywork has been repaired, is given in Section 6.7.4.

6.6 BODYWORK EQUIPMENT

6.6.1 Driver's and passenger's seats



6.31. Figure: DRIVER AND PASSENGER SEATS (FOTELE KIEROWCY I PASAŻERA)

a - driver's seat, b - passenger seat, 1 - complete seat, 2 - backrest cover, 3 - backrest cushion, 4 - passenger seat frame, 5 - seat cover, 6 - seat cushion, 7 - battery cover, 8 - lid gasket, 9 - seat base, 10 - side cover, 11 - centre guide of the travel mechanism. 12 - driver's seat base 13 - side guide of the displacement mechanism, 14 - rod pin, 15 - return spring. 16 - rod buckle, 17 - backrest lever, 18 - seat back adjustment lever, 19 - driver's seat frame. 20 - Horizontal adjustment lever for the seat, 21 - attachment for the seat

a - fotel kierowcy, b - fotel pasażera, 1 - fotel kompletny, 2 - poszycie oparcia fotela, 3 - poduszka oparcia, 4 - szkielet fotela pasażera, 5 - poszycie siedzenia, 6 - poduszka siedzenia, 7 - pokrywa akumulatora, 8 - uszczelka pokrywy, 9 - podstawa fotela, 10 - nakladka boczna, 11 - prowadnica środkowa mechanizmu przesuwu. 12 - podstawa fotela kierowcy 13 - prowadnica boczna mechanizmu przesuwu, 14 - sworzeń drążka, 15 - sprężyna powrotna. 16 - zapinka drążka, 17 - drążek regulacji oparcia, 18 - dźwignia regulacji oparcia fotela, 19 - szkielet fotela kierowcy. 20 - dźwignia regulacji przesuwu poziomego fotela, 21 - zaczep mocowania fotela

Two seats are fitted in the driver's cab on a fixed base welded to the floor: the driver and the passenger (Fig. 6.31). The driver's seat (a) shall be adjustable horizontally and have an adjustable backrest angle. The passenger seat (b) has no adjustment. It is attached at the front to the base (9) with two hinges and at the rear with two catches (21). This seat attachment (1) allows access to the battery by tilting the seat forwards.

The driver's seat consists of a frame (19) with seat cushions (6) and backrest (3), a forward and backward adjustment mechanism (11) and a backrest tilt adjustment mechanism (17 and 18).

6.6.1 Driver's and passenger's seats

The seat and back cushions are made of polyurethane foam and the outer cushions of artificial fabric. The driver's seat frame (19) consists of a seat frame made up of a channel and a backrest frame (of steel tube).

Internal slides (11) with displacement adjustment mechanism and external slides (13) are attached to the seat frame. Pressing the lever knob (20) downwards will cut the clip out of the skirting board and move the driver's seat to a convenient position.

The angle of inclination of the backrest is slightly adjustable by lever (18); by screwing it is lifted, by unscrewing it it is lowered. When adjusting the back angle by steps, raise the lever, position the backrest in the desired position and lower the lever downwards.

To remove the driver's seat, proceed as follows

- slide the seat forward and loosen the two screws securing the guide bar with steel (inside and outside),
- slide the seat backwards and loosen the two retaining screws to remove the seat.

To remove the passenger seat, proceed as follows:

- raise the lever of the outer and middle locking devices (21), disconnect the drawbar eye (21) and tilt the seat forwards,
- unscrew the six screws holding the hinges to the base and remove the seat.

Installation of the seats in the car should be done in the reverse order. When doing so, the rollers and balls must be lubricated with grease.

6.6.2 Seats and benches for passengers

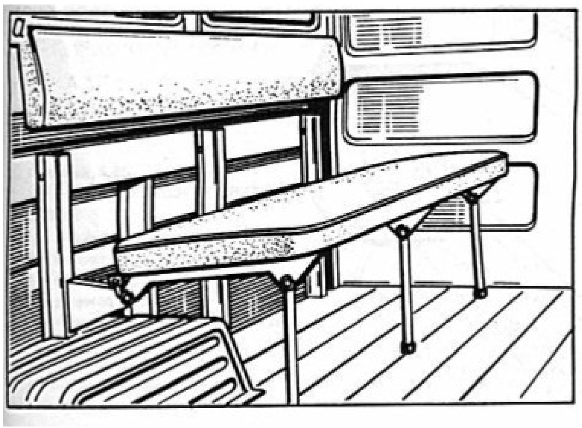
In the car Zuk A07 along the side walls there are two folding benches with backrest (Fig. 6.32), on which can sit a total of 5 people. The larger bench is 1550 mm long, 350 mm wide and the shorter bench is 734 and 350 mm shorter respectively. The bench base is made of thick plywood, on which polyurethane foam cushions are placed and covered with artificial leather. The benches are pulled vertically by the lever mechanism (hinged to the vertical posts of the body's side walls).

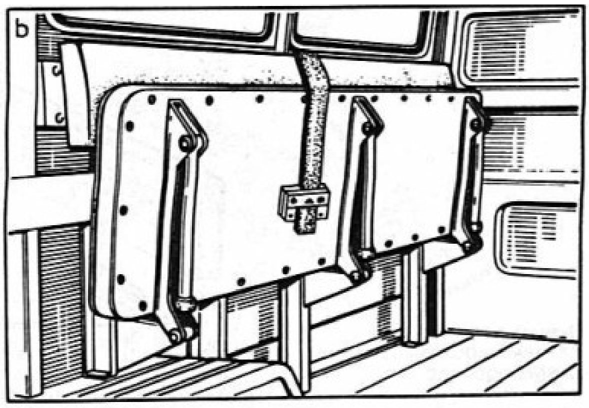
When transporting loads, the benches can be folded down. To do this, first lift the bench upwards, then slide it to the side wall and secure it with a strap. Two folding benches for four people are fitted in the rear of the extended A16 cab. The A18 minibus uses seats for 9 people including the driver (Fig. 6.32d).

In the compartment of the fire-fighting vehicle A15 there is a sofa bed with support for two crew members (Fig. 6.33). It is located across the car by the wall of the rear cabin, fixed on the base (3), screwed to the floor. The sofa bed is used for extinguishing equipment.

In the compartment of fire-fighting vehicle A151 by the rear wall of the cabin, a folding seat (straponten) for one crew member is fixed. The seats in the fire-fighting vehicles are made of the same materials as those used in the A07 vehicle.

6.6.2 Seats and benches for passengers

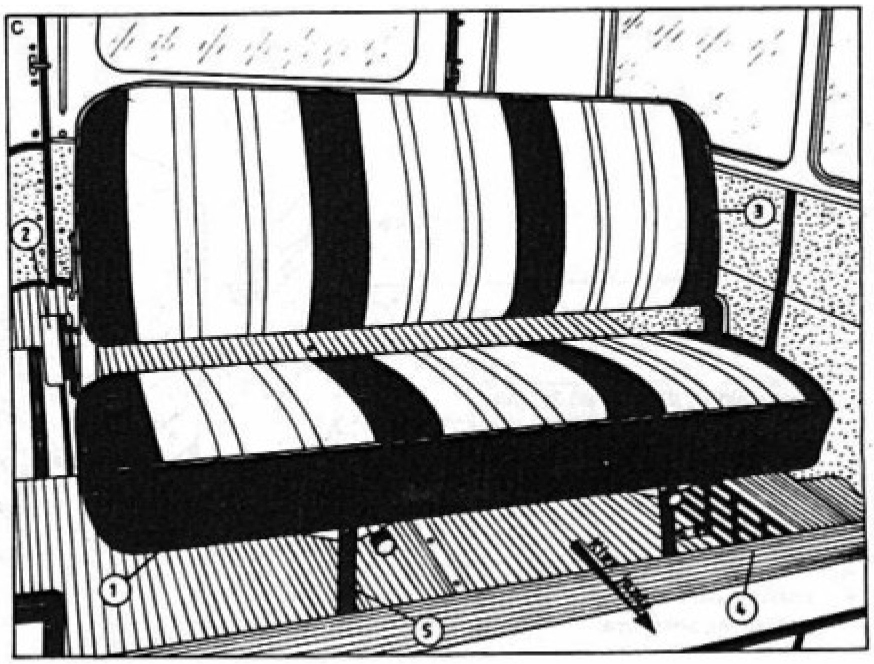


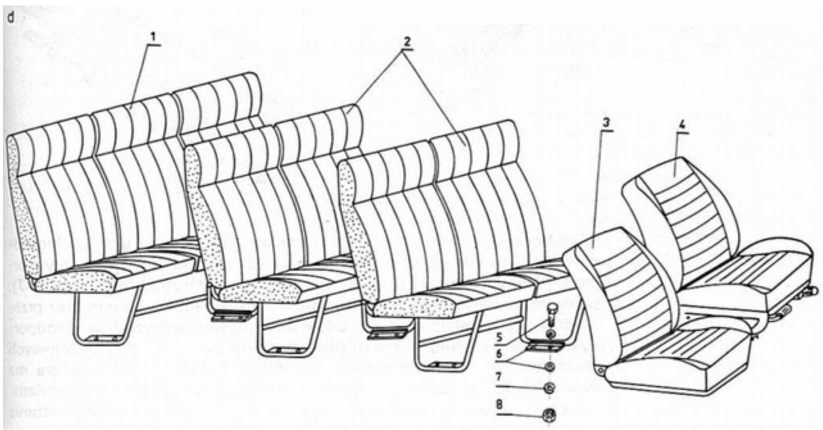


a - left lava folded out, b - folded left avalanche, c - operating sofa :
1 - Bottom cushion, 2 - locking mechanism, 3 - sofa support, 4 - cab front wall, 5 - sofa leg
d - A18 minibus armchairs :
1 - rear seat for three people. 2 - different-seater centre seats, 3 - passenger seat, 4 - driver's seat. 5 - screw (M8 x 85), 6 - padding, 8,5,7 - elastic washer, 8 - nut M8

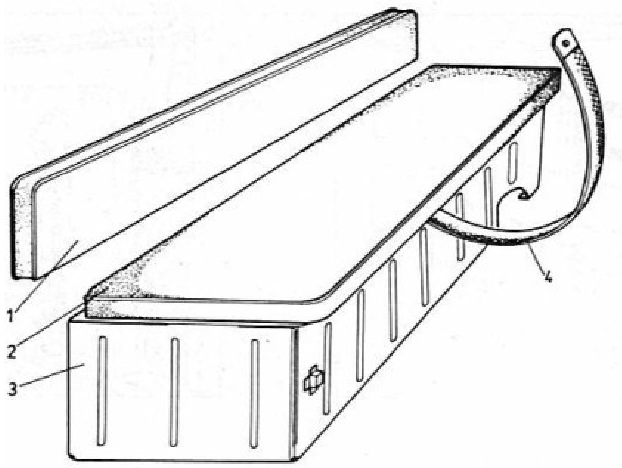
a - lawka lewa rozłożona, b - lawka lewa złożona, c - kanapa obsługi:
1 - poduszka dolna, 2 - mechanizm blokowania, 3 - oparcie kanapy, 4 - przednia ściana kabiny, 5 - noga kanapy

d - fotele mikrobusu A18:
1 - trzyosobowy fotel tylny. 2- dwuosobowe fotele środkowe, 3- fotel pasażera, 4 - fotel kierowcy. 5- śruba (M8 x 85), 6 - podkladka, 8,5,7 - podkładka sprężysta, 8- nakrętka M8





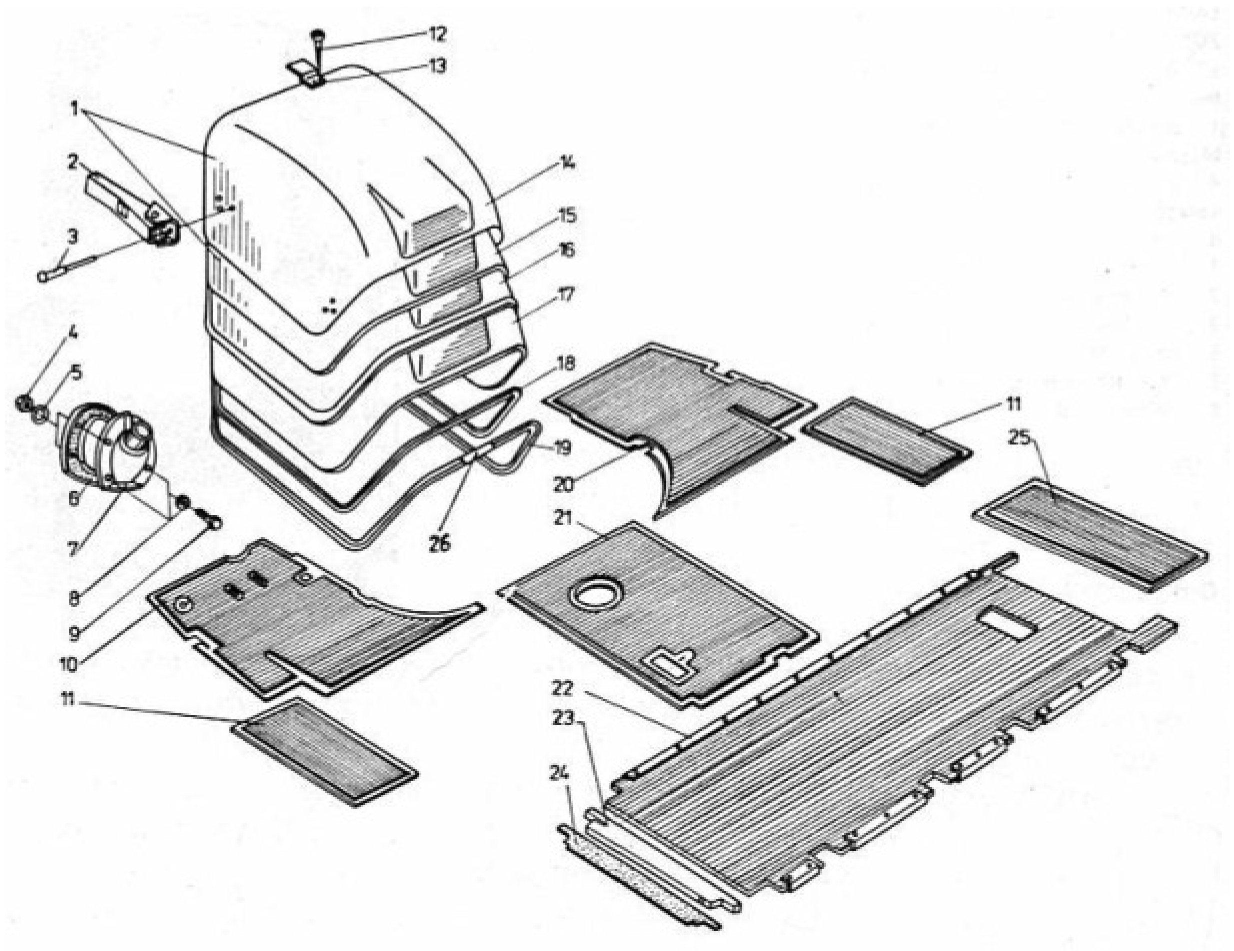
6.32. Figure: FOLDING BENCHES AND CHAIRS IN CAR ZUK A07/A18



1 - backrest of the sofa, 2 - backrest of the sofa. 3 - sofa base, 4 – belt

1 - oparcie kanapy, 2 - poduszka kanapy. 3 - podstawa kanapy, 4 - pasek

6.33. Figure: SOFA OF THE CREW OF THE A15C FIREFIGHTING VEHICLE



6.34. Figure: ENGINE COVER, CAB FLOOR MATS (OSŁONA SILNIKA, DYWANIKI PODŁOGI KABINY)

1 - motor cover, 2 - latch, 3 - rivet. 4 - nut M6, 5 - washer, 6 - shield gasket, 7 - steering column cover, 8 - padding, 9 - screw M6x16, 10 - left carpet. 11 - carpet for cabin step, 12 - sheet metal screw, 13 - fastener, 14 - cover sheet. 15 - bag liner, 16 - metal liner, 17 - insulation liner. 18 - protective cord, 19 - protective gasket. 20 - right carpet. 21 - centre carpet, 22 - rear carpet*. 23 - side rail*. 24 - sealing insert*, 25 - side door mat**, 26 - seal lock
* For A16 cars.
** For vans.

1 - osłona silnika, 2 - zamek, 3- nit. 4 - nakrętka M6, 5 - podkładka, 6 - uszczelka osłony, 7 - osłona kolumny kierownicy, 8 - podkladka, 9 - śruba M6x16, 10 - dywanik lewy. 11 - dywanik stopnia kabiny, 12 - wkręt do blach, 13 - łącznik, 14 - poszycie pokrowca. 15 - wykładzina pokrowca, 16 - oslona metalowa, 17 - wykladzina izolacyjna. 18 - sznur osłony, 19 - uszczelka oslony. 20 - dywanik prawy. 21 - dywanik środkowy, 22 - dywanik tylny kabiny. 23 - listwa boczna*. 24 - wkładka uszczelniająca*, 25 - dywanik drzwi bocznych**, 26 - zamek uszczelki*

** do samochodów A16.*
*** do samochodów furgon.*

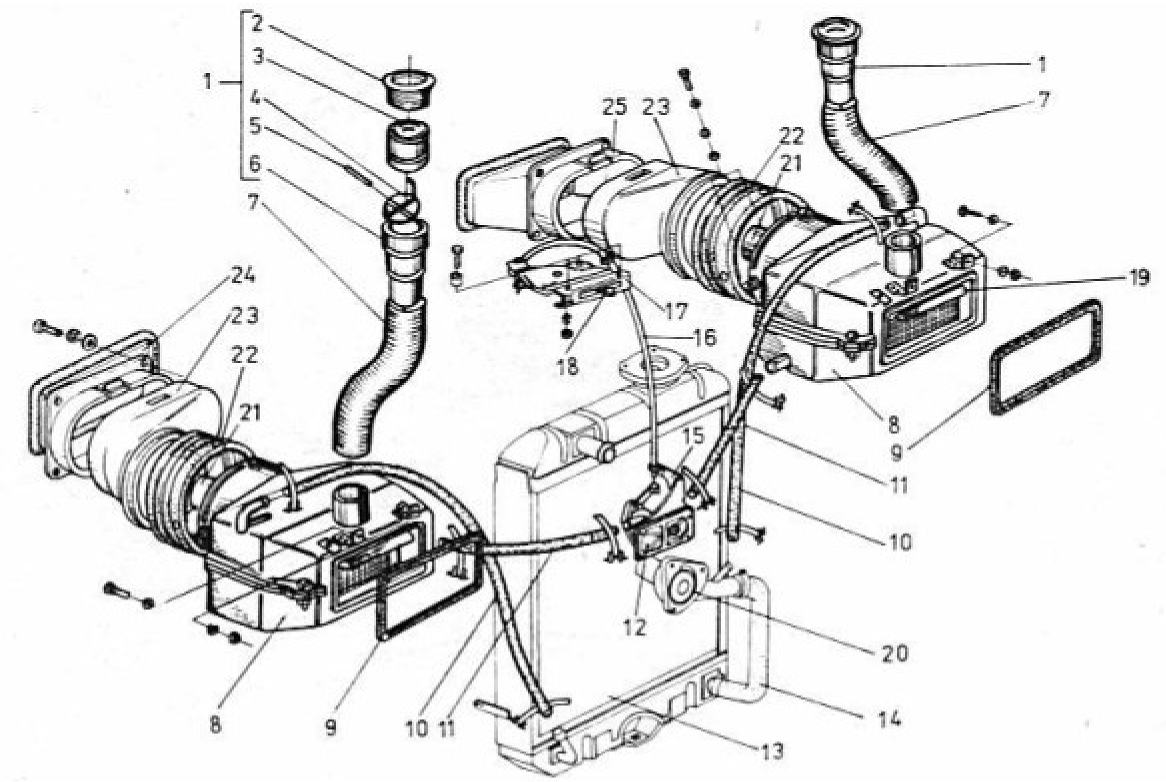
6.6.3 Ventilation and heating system

This system supplies fresh air to the interior of the car with the windows closed. The air is either cool or heated, as required.

The ventilation and heating system (Figure 6.35) distributes this air to the windscreen and under the driver's and passenger's feet. It also gives the possibility of blowing air into the car when it is stationary by means of the valve of electric bags (21), located inside the casing on the heaters. The air enters the interior of the vehicle through the ducts (23) located in the front of the cabin under the external cover.

6.6.3 Ventilation and heating system

The heating system uses hot liquid from the engine cooling system. Consists of two heaters (8) with integrated fans (21), valve (12), engine head, control unit (17), rubber tubes (10,11) with an external diameter of 16 mm and tubes (7) with an external diameter of 50 mm made of aluminium foil, covered with waterproof paper. The heaters (8) are housed in two-piece plastic housings. The electric motor of the fan has an output of 8 W and 3600 rpm. A plastic fan is mounted on the impeller shaft. The heater consists of a brass tubular core with 0.15 mm thick ribs. The heater core is finished with 0.5 mm brass sheet metal tanks on both sides. In the bottom of one tank there is a soldering nozzle supplying the radiator, and in the second - a nozzle discharging liquid to the radiator and further to the engine. The radiators shall be tested for leakage at a pressure of 100 kPa. Heating is controlled from the driver's cab by moving the lever (18) connected to the valve lever (12) to the rightmost extreme position. The heater valve is controlled by a lever (13) from the driver's cab by a 1,5 mm steel wire rod (16), placed in an armour.



6.35. Figure: CABIN VENTILATION AND HEATING SYSTEM (UKŁAD WENTYLACJI I OGRZEWANIA KABINY)

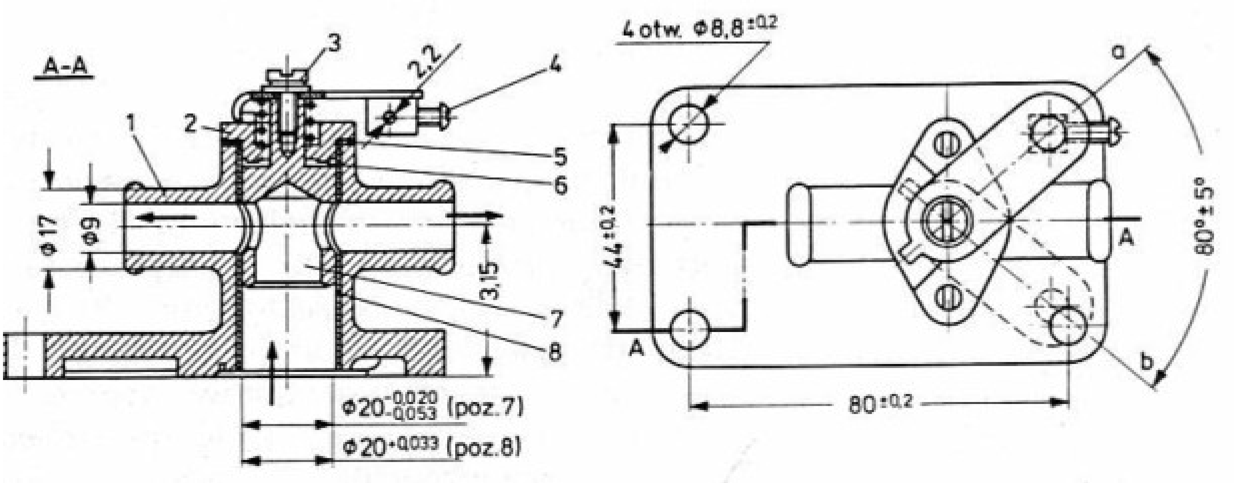
1 - blowing handlebar, 2 - flange, 3 - steering wheel, 4 - throttle, 5 - throttle axis, 6 - end, 7 - blowing duct, 8 - heatingplate, 9 - gasket, 10 - right inlet duct, 11 - left inlet duct. 12 - heating system valve, 13 - water cooler, 14 - radiator lower tube, 15 - tendon armour support, 16 - valve tendons. 17 - control mechanism. 18 - control lever, 19 - blowing flap, 20 - water pump, 21 - fan motor heaters, 22 - rubber bushing, 23 - rubber switch, 24, 25 - air inlets

1 - kierownica nadmuchu, 2 - obrzeże, 3 - kierownica, 4 - przepustnica, 5 - oś przepustnicy, 6 - końcówka, 7 - przewód nadmuchu, 8 - nagrzewnica kpl, 9 - uszczelka, 10 - przewód wlotowy prawy, 11 - przewód wlotowy lewy. 12 - zawór układu ogrzewania, 13 - chlodnica wody, 14 - przewód dolny chłodnicy, 15 - wspornik pancerza cięgna, 16 - cięgno zaworu. 17 - mechanizm sterujący. 18 - dźwignia sterowania, 19 - przesłona nadmuchu, 20 - pompa wody, 21 - silnik wentylatora nagrzewnicy, 22 - tuleja gumowa, 23 - lacznik gumowy, 24, 25 - wloty powietrza

This valve (Fig. 6.36) is located on the engine head. It consists of a body (1) cast aluminium alloy with a bronze bushing (8) and a brass throttle (7).

6.6.3 Ventilation and heating system

Heating is switched on by moving the lever (18, fig. 6.35) connected to the valve lever to the right in its extreme position. The heated air is directed from the left heater to the driver's feet and the tube (7) to the left side of the windscreen, while from the right heater to the passenger's feet and to the right side of the windscreen.



6.36. Figure: LIQUID SUPPLY CONTROL VALVE FOR THE HEATERS (ZAWÓR STERUJĄCY DOPŁYWEM CIECZY DO NAGRZEWNIC)

1 - valve body, 2 - cover, 3 - screw (M4x8), 4 - cable clamping screw, 5 - gasket. 6 - sealing ring. 7 - throttle, 8 - body sleeve a - closed valve, b - open valve

1 - korpus zaworu, 2 - pokrywa, 3 - wkręt (M4x8), 4 - wkręt dociskowy cięgna, 5 - uszczelka. 6 - pierścień uszczelniający. 7 - przepustnica, 8 - tuleja korpusu a - zawór zamknięty, b - zawór otwarty

Cab ventilation is carried out by means of fans (21) with the heating switched off. They are switched on simultaneously by means of a key switch on the dashboard.

When driving, the most intensive natural ventilation of the cab takes place when the windows in the left and right cab doors are moved. The above described ventilation and cabin heating system is used in cars with S-21 petrol and 4C90 diesel engines, except that only other valves (12, Fig. 6.35), inlet ducts (11) and other control mechanisms (17, Fig. 6.35) are installed in the diesel system.

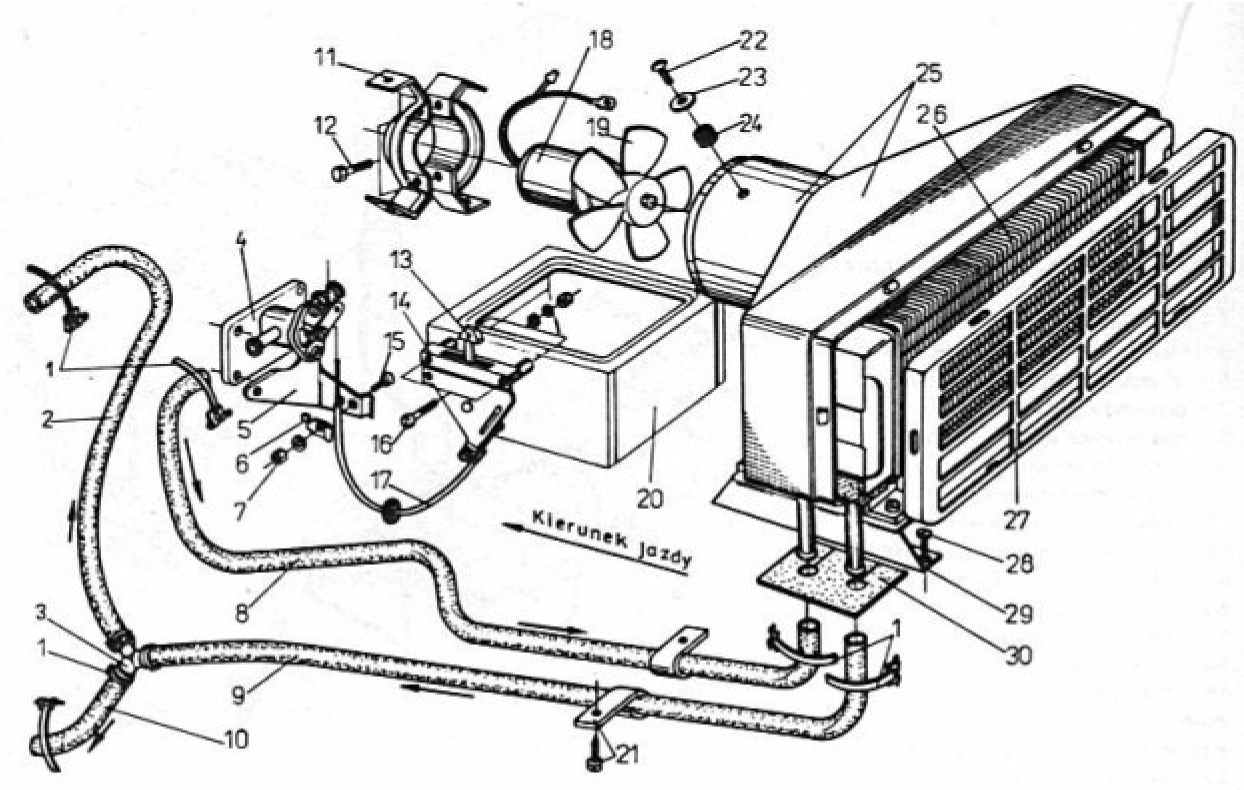
In freight and passenger cars A062, A072 and in minibus A18, additional heating of the passenger compartment is used (Fig. 6.37) with a heater that also draws hot liquid from the engine cooling system. In the car A072 the heater is placed under the fixed bench in the escort compartment, and in the mini-bus A18 - by the wall of the rear cabin in the passengers' room.

To remove the heater and fan, disconnect the lower and upper parts of the casing and unscrew the defective parts. Check the heaters for cracks and leaks and that the pipes are tight. Leakage heaters can be soldered with tin or brass.

Check the function of the valve (4, Fig. 6.37) for jams and leaks. If the electric motor (18) does not work, disassemble it and check the condition of the commutator and the brushes, which should move slightly in the sockets without resistance. The commutator should not be burned, it should be cleaned with abrasive paper and cloth. Blow out the inside of the motor with compressed air to remove the impurities.

6.6.3 Ventilation and heating system

After inserting and mounting the motor to the heater, check the tightness and functioning of the entire ventilation and heating system. Lubricate the control rod rope (17) with engine oil and the liquid control valve with graphite dust.



6.37. Figure: HEATING SYSTEM FOR THE PASSENGER COMPARTMENT (A18, A072)

1 - compression band, 2, 9, 10 - water supply lines to the radiator. 3 - T-piece, 4 - water valve, 5 - tendon support, 6 - tendon clamp, 7 - nut. 8 - water inlet pipe. 11 - motor bracket. 12 - M5x16 screw, 13 - heating control lever, 14 - lever base, 15 - M6x16 screw, 16 - M5x35 screw. 17 - control string, 18 - 12 V heater motor. 8 W. 19 - fan, 20 - passenger seat base, 21 - cable holder with screw, 22 - screw M5x16. 23 - padding, 24 - rubber gasket, 25 - heater housing. 26 - radiator. 27 - housing cover, 28 - screw. 29 - heater bracket. 30 - gasket

1 - opaska zaciskowa, 2, 9, 10 - przewody dopływu wody do chłodnicy. 3 - trójnik, 4 - zawór wodny, 5 - wspornik cięgna, 6 - zacisk cięgna, 7 - nakrętka. 8 - przewód dopływu wody. 11 - obejma silniczka. 12 - śruba M5x16, 13 - dźwignia sterująca ogrzewaniem, 14 - podstawa dźwigni, 15 - wkręt M6x16, 16 - śruba M5x35. 17 - cięgno sterowania, 18 - silnik nagrzewnicy 12 V. 8 W. 19 - wentylator, 20 - podstawa fotela pasażera, 21 - uchwyt przewodów z wkrętem, 22 - wkręt M5x16. 23 - podkladka, 24 - uszczelka gumowa, 25 - obudowa nagrzewnicy. 26 - grzejnik. 27 - pokrywa obudowy, 28 - wkręt. 29 - wspornik nagrzewnicy. 30 - uszczelka

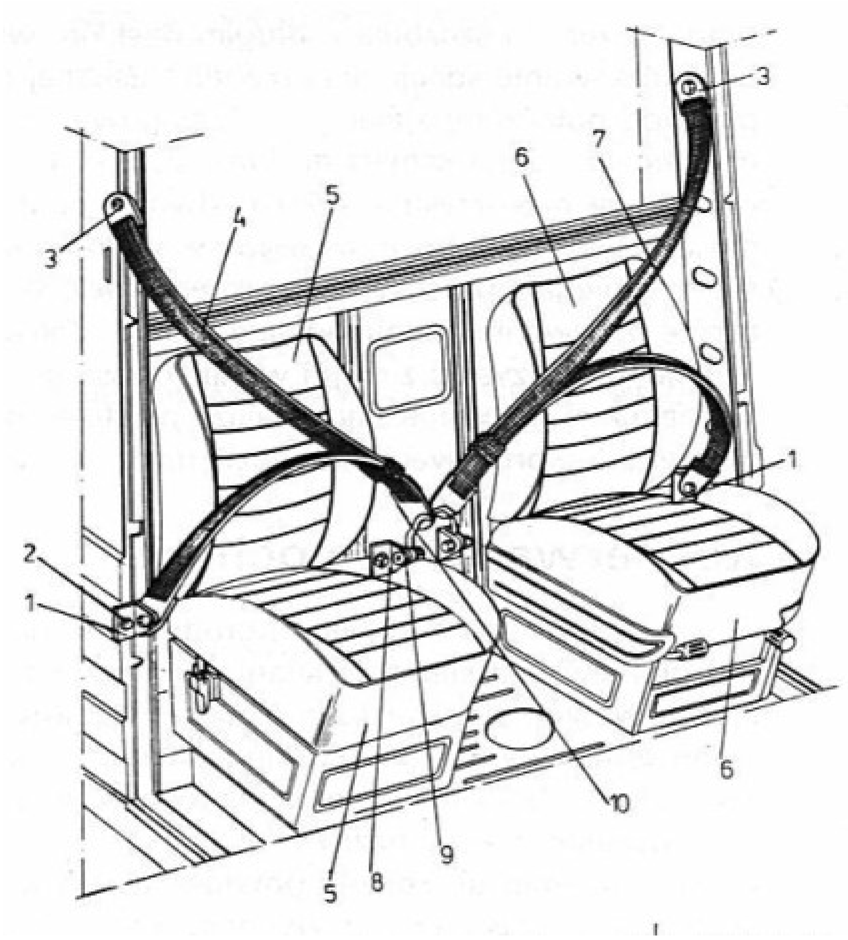
6.6.4 Seat belts and equipment

In all cars, the seat belt holders (Fig. 6.38) for the driver and passenger are installed in the cabin. These handles are designed for fastening hip and dog safety belts, type BP, PN-75/S-80051, which the factory assembles only on request of the recipient of the car.

The safety belt is bolted to three points. The upper end of the chest strap is bolted to the threaded seat in the rear pillar of the cab. The seats are located symmetrically on both sides of the cab, above the driver and passenger seats. The ends of the lap belt are attached to the centre holder on the rear panel and to the side holder on the side panel. Observe the instructions in the operating manual when fastening and using the belts.

■ Rear-view mirrors. Two exterior rear-view mirrors are used in the car (Figure 6.39). They are attached to the top hinge pins (1) of the cab door. The mirror (6) is mounted on a suitable arm (5), tilting it on a plastic ball joint. The pivot point of the mirror is attached to the housing by means of

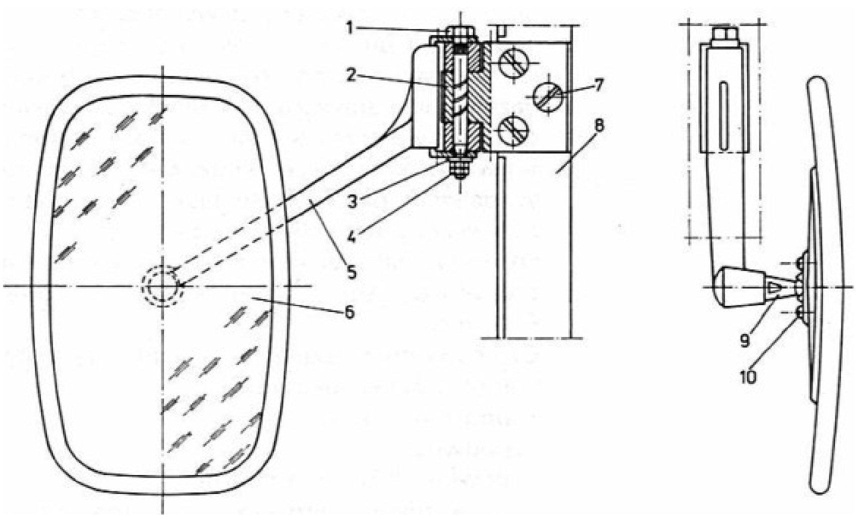
two ball-socket washers and three M4x8 screws, which allow the mirror to be adjusted to the driver's needs.



1 - belt support, 2, 3 - screws. 4 - passenger safety belt, 5 - passenger seat, 6 - driver's seat. 7 - driver's seat belt. 8 - lower belt anchorage, 9 - Screw, 10 - belt attachment bracket

1 - wspornik pasa, 2, 3 - śruby. 4 - pas bezpieczeństwa pasażera, 5 - fotel pasażera, 6 - fotel kierowcy. 7 - pas bezpieczeństwa kierowcy. 8 - uchwyt dolny pasa, 9 - Sruba, 10-jarzmo mocowania pasa

6.38. Figure: SAFETY BELTS (PASY BEZPIECZEŃSTWA)



1 - top hinge pin. 2 - hinge, 3 - padding, 4 - nut M6, 5 - left arm. 6 - exterior mirror, 7 - screw. 8 - left wall, 9 - ball pin, 10 – screw

1 - sworzeń zawiasy górnej. 2 - zawiasa, 3 - podkladka, 4 - nakrętka M6, 5 - ramię lewe. 6 - lusterko zewnętrzne, 7 - wkręt. 8 - ściana lewa, 9 - sworzeń kulowy, 10 - wkręt

6.39. Figure: LEFT EXTERIOR MIRROR (LUSTERKO ZEWNĘTRZNE LEWE)

6.7 BODY MAINTENANCE AND REPAIR

6.7.1 Washing

The bodywork shall be cleaned and washed after each mudding and dusting (preferably immediately after the end of the journey). Start washing the car with water from the inside, the floor and the thresholds, then start washing the roof and the surfaces of the upper body walls. It is recommended to use water supplied with the hose from the water supply system and a bristle brush for cleaning. The bodywork shall not be washed on hot days in the sun or in ambient temperatures below 0°C. It is advantageous to use shampoos that ensure thorough removal of impurities.

After the carpets have been removed from the interior, the whole body is rinsed with water, wiped with a long soft bristle brush or sponge. Cleaning is facilitated by using a special brush which is supplied from the inside by a rubber hose connected to the water supply system. After washing, the body should be wiped dry with rags or dried. Leaving the car wet is disadvantageous, as the body absorbs dust, which significantly accelerates corrosion, especially in summer, when the chemical processes of corrosion are the fastest. In winter, it is recommended to frequently wash and rinse off the salt on the lower surfaces of the body. You can also use the car wash at the service station.

The body must be wiped at least once a month with a suitable bodywork maintenance agent (section 6.7.2).

6.7.2 Corrosion protection

The main reasons for the rapid corrosion of the body are moisture, salt solutions and sulphur compounds. These factors are particularly intense in areas where moisture evaporation is difficult (gaps, joints, closed profiles, etc.). The protective coating that is applied to the new body at the factory is also subject to mechanical damage during its operation.

If any damage is found to the paint film, it must be repaired as soon as possible. Car maintenance (chassis, body and profiles) is best carried out on warm and sunny days indoors or outdoors at 18...25°C (preferably in summer). The first anti-corrosion protection is recommended immediately after the purchase of the vehicle, as it eliminates laborious preparatory work such as removing mud, cleaning rust, cleaning and varnishing mortars.

The corrosion protection should be carried out every 12 months during the further period of operation.

Periodic protection of the lacquer coatings should be performed with dedicated preparations, listed in tables 6-6, 6-7 and 6-8.

The following car assemblies are subject to periodic protection:

- closed profiles of the bodywork,
- cab floor,
- chassis,
- lacquer coating (outer body).

Before any corrosion protection measure, thoroughly wash and dry the vehicle, remove the running wheels and cover the brake drums with a film, and remove or protect the seats in the driver's cab.

6.7.2 Corrosion protection

Product name	Coating thickness	Spray device to be used, type	Application location	Application period
Fluidol ML (lanolin wax composition) or Akonin	0,15...0,025 mm	IMP-OC1	closed profiles, joints, welded joints	every 12 months
Bitex (asphalt wax preparation) or Cyclokor	0,5...1,5 mm by double spraying	IMP-OC2	lower body panels and chassis assemblies, mudguards, chassis and steering components, internal surface of the front bumper	after 15,000 km or every 12 months
Auron (wax paste)		WAN-4C	bodywork lacquer coating	at least once a month
Autozol (wax paste)		spray preparation	– ‘’ –	
Wosol (paste for polishing stove lacquers)		– ‘’ –	– ‘’ –	
Car paste (wax solvent)		flannel tampons		
Inhibol (protective oil)	several drops	oiler	locks, hinges, adjusting screws	every month in winter, every 2 or 3 months in summer
Protektol (solution of synthetic gasoline waxes)	as much as necessary	flannel tampons	chromium plated or nickel plated electroplating	every 1 month

6.6. Table: ANTI-CORROSION PREPARATIONS/WAX PASTES TO PROTECT LAQUERED BODY SURFACES

Cabin floor maintenance. The maintenance operations are as follows:

- lift the vehicle on the elevator and remove the wheels,
- thoroughly wash the underside of the vehicle with warm water under pressure and completely dry (preferably with compressed air),
- review the corrosion protection,
- repair damage, clean exposed sheet metal surfaces of rust, degrease with extraction gasoline, primer with anticorrosive primer (Penetrol or Autochronous),
- secure the brake discs and drive shaft with packaging paper or polythene film,
- apply Bitex by spraying over the entire surface, paying particular attention to the precise coverage of the recesses, front and rear mudguards, the lower parts of the body sidewalls, the thresholds and the cab floor (the preparation must be thoroughly mixed before use); the thickness of the coating should be 0,5...1,5 mm after double spraying,
- wash off visible surfaces of the sheet metal with white spirit to remove traces of corrosion protection agent.

6.7.2 Corrosion protection

	Bitex or Cyklokor	Tectyl-Chassiss (TL121 Export)	Dinitrol-Car
Country, producer	Sp-nia pracy ,,Chemia" Olesin	Switzerland, company Valvoline	Sweden, company Astra Tikamin
Characteristics of the coating	black, elastic, rubberized does not retain mud	dark brown, semi-hard and elastic	black, semi-hard elastic
Flash point (°C)	35...38	35	min. 41
Coat thickness after one application (µm)	min. 300	250	500
Drying time (h)	12	1,5	3
Capacity (m^2/kg)	1...1,5	2...3	2...3
White spirit washability	good	good	good
Period of protection (months)	12 months or 15...20 thousand km*	12	12

* The value previously achieved is taken into account.

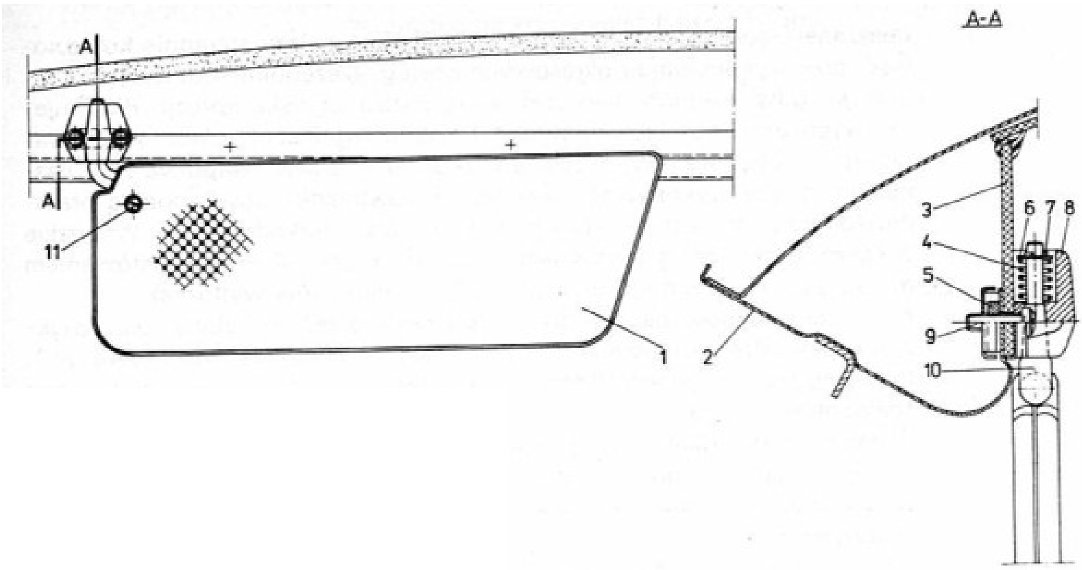
6.7. Table: ANTI-CORROSION PREPARATIONS TO PROTECT CHASSIS AND LOWER BODY PANELS

	Fluidol ML or Akonin	Tectyl ML (141B)	Dinitrol 33B
Country, producer	Sp-nia pracy ,,Chemia" Olesin	Switzerland, company Valvoline	Sweden, company Astra Tikamin
Characteristics of the coating	thin, elastic, displaces moisture from the metal surface, homogeneous, amber-coloured	elastic, waxy, homogeneous, heat resistant, displacing moisture from the metal surface	soft, petroleum-waxy, light brown, non-drying, homogeneous
Flash point (°C)	30	38...42	35
Coating thickness (µm)	20...25	25	25
Drying time (h)	0,5	0,5	1
Viscosity according to Ford cup n° 4,s	18...20	18...20	20...22
Period of protection (months)	12	12	12

6.8. Table: ANTI-CORROSION PREPARATIONS TO PROTECT ENCLOSED SPACES

Maintenance of the chassis. Use Bitex or Cyclokor to maintain the chassis. These preparations are applied by spraying (or brush) only on the painted surfaces of the chassis.

Bitex should not be applied to the engine, exhaust pipe, gearbox, main transmission housing, starter, generator, drive shaft (due to the increased operating temperature of these units). When securing the mudguards (after removing the wheels), protect the brake drums to prevent them from dripping with preservative.



6.40. Figure: SUN BLINDS (PRZYSŁONY PRZECIWSŁONECZNE)

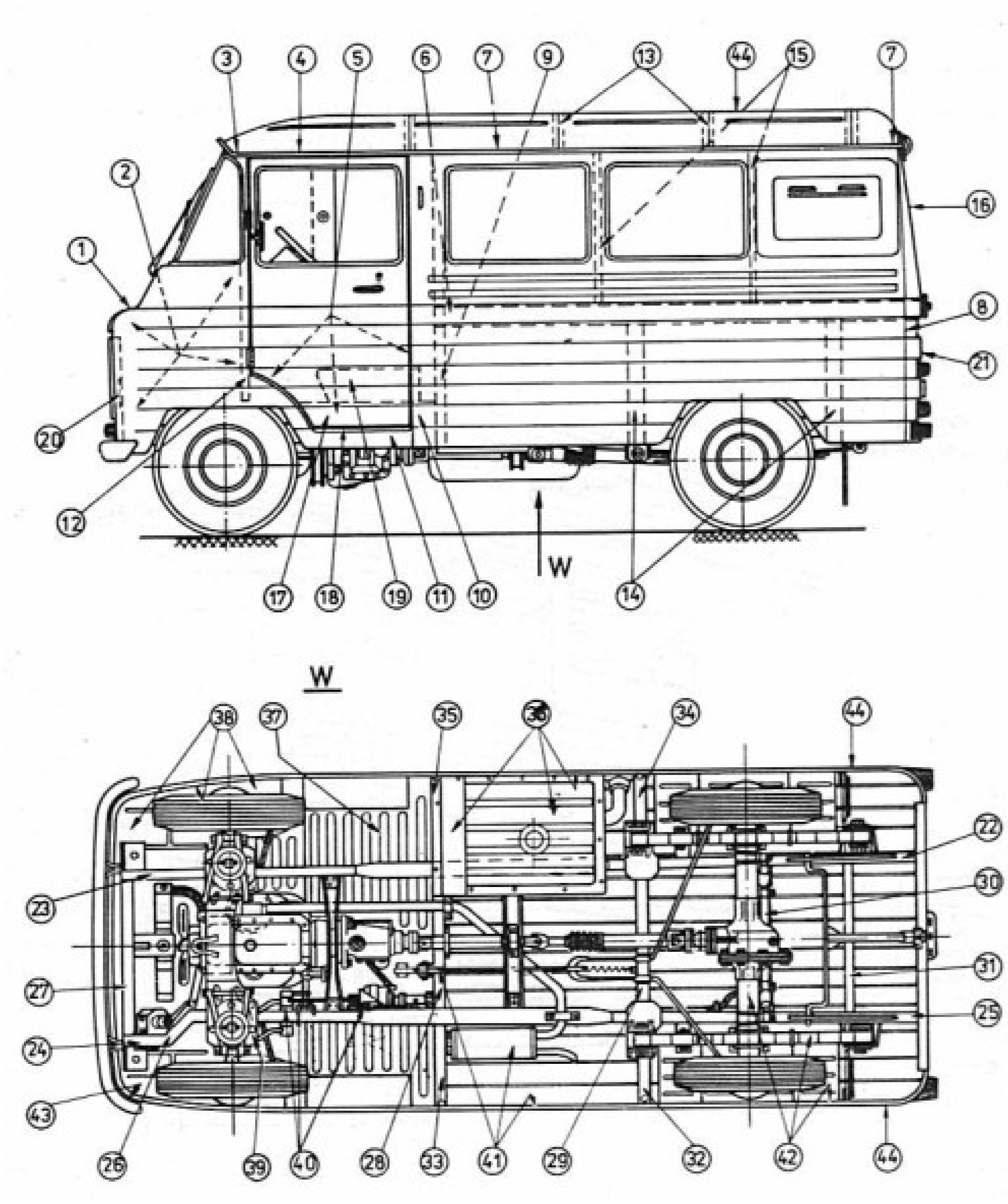
1 - shutter-plate, 2 - cab cover. 3 - front liner, 4 - spring, 5 - nut, 6 - round pad, 7 - pin, 8 - shutter handle. 9 - screw. 10 - tip cone. 11 - compression screw

1 - przysłona, 2 - poszycie kabiny. 3 - poszycie wewnętrzne przednie, 4 - sprężyna, 5 - nakrętka, 6 - podkladka okrągła, 7 - zawleczka, 8 - uchwyt przysłony. 9 - wkręt. 10 - końcówka stożkowa. 11 - wkręt dociskowy

Body maintenance. Surfaces intended for maintenance must be thoroughly cleaned and dried. Shampoos can be used for washing, which must then be rinsed off very thoroughly (preferably with warm water). After thorough drying, apply the wax paste (Autozol or Auron) to the cotton wool tampon or the bellows of the flannel and carefully place it in the surface to be conserved. Then polish with a dry, soft flannel or mechanical polisher to a glossy finish. Any paint system with its own tank or powered from a pressure tank can be used for maintenance of the lacquered body surface with liquid preparations or emulsions.

6.7.3 Body repair

During operation, the car body undergoes natural aging, various mechanical damage and is destroyed by corrosion, due to moisture and aggressive environment (mud and snow, mixed with salt in winter). Therefore, when carrying out periodic maintenance, the lower parts of the bodywork in particular should be carefully inspected, as they are the earliest to cause corrosion. In the event of local bodywork damage (small dents in the sheets, scratches, etc.), the paint will also be damaged. These damages should be repaired immediately after they have occurred in order to prevent the accelerated corrosion of damaged surfaces. All major damage requires sheet metal repair with rectification of damaged areas or replacement of whole parts of the extrusion.



6.41. Figure: PERIODIC CARE SAMOCHOD ZUK, Symbols according to Table 6.9

Fig. 6.41 ref.	Symbol	Location and preparation	To carry out	Recommended equipment
1		Reinforcement of the cab front cover (drill holes 20 cm from the end of the reinforcement)	Bi-directional spraying, complement frontal spraying with radial spraying.	Curved front nozzle, radial nozzle (flexible nozzles)

2		Internal surfaces of the front corners (better access is achieved by loosening the mounting screws of the heaters)	Forward, reverse and upward spraying with front and radial nozzles	– ,, –
3		Front underbody beam	Spraying along the front weld seam	Front nozzle curved
4		Roof beam over cab door	Spraying along the weld seam	– ,, –
5		Lower cab door and van side door space (accessible by removing the door cover)	Spraying in all directions	– ,, –
6		Skeleton beam for the side walls of a van and pick-up	Bottom spraying along the beam	– ,, –
7		Body underfloor beams - side and rear	Spraying along the beams	– ,, –
8		Rear corner - right and left bodywork	Spraying in all directions	– ,, –
9		Side post in vans not (drill hole on the side of the cargo area at the height of the hole drilled in the front door pillar - see item 12)	Spraying in all directions. Top up with radial spray.	Front and radial nozzles with flexible nozzle
10		Rear door pillar of the cab	Spraying through the profile holes in the post, especially in the lower direction	Front and radial nozzles with flexible nozzle
11		Threshold beam (drill two holes from the bottom 50 mm from the end of the sill)	Spray up, forward and backward. Fill in the front spray with radiant water.	– ,, –
12		Cab door front post (drill a 130 mm hole from the lower hinge upwards)	Spray up and down. Complete radial spraying with a frontal spray.	– ,, –
13		Stiffeners across the roof (drill two holes in each 300 mm strip from the side beam)	Spraying in both directions frontal spraying must be carried out by means of radial spraying	Curved front nozzle, radial nozzle (flexible nozzles)
14		Lower stiffening posts at the rear of the bodywork of the van and the pick-up	Spraying along the posts	Front nozzle curved

15		Upper (inter-window) stiffening posts at the rear of the bodywork of the van (drill holes at mid-point of the post)	Spray up and down. Top up with a radial spray.	Front and radial nozzles with flexible nozzle
16		Upper rear door leaf	Internal spraying, especially along the lower edge	The front nozzle bends.
17		The edges of the cabin doors and the side and rear doors of the van are as follows	Spraying from the outside at the joint of the sheets	Front nozzle
18		Step under cabin and side doors of the van	External spraying of sheet metal joints	– ,, –
19		Seat bases (tool holders and batteries)	Indoor and outdoor spraying at the joint of sheet metal	Front nozzle
20		Headlamp surround	External spray	Front nozzle
21		Lower rear door leaf (access after removal of the inner covering)	Internal spraying especially along the edge	Front nozzle with curved nozzle.
22 23		The right hand side of the frame	Radial and frontal spraying along the side-members from the front and rear	Front and radial nozzles with flexible nozzle
24 25		Left-hand side member (hole 24 drilled at front in the longitudinal axis)	Radial spraying along the side-members from the front and rear	Flexible front and rear jet nozzles
26		Steering gear bracket	Radial spraying in both directions	– ,, –
27		Front frame crossbar	Internal spraying along the crossbar	– ,, –
28 29 30 31		The centre bars of the frame	Radial and frontal spraying in all directions	Front and radial nozzles with flexible nozzle
32 33 34 35		The edge bars of the frame	Radial and frontal spraying in all directions	– ,, –

36 37 38 39 40 41 42	◌	Chassis assemblies and lower body sections	Double-spray the entire chassis from below carefully - especially the mudguard recesses and hard-to-reach areas, the thresholds and all sheet and edge joints.	Gun for thick masses IMP-OC2 type
43	◌	Internal surface of the front bumper	Spray carefully	Front nozzle with curved nozzle.
44	◌	Exterior painted surfaces of the bodywork	Carefully apply the wax paste to the exterior of the painted surfaces after each car wash at least once a month.	Aerosol face spraying or tampon rubbing

Meaning of symbols:

◌ surfaces to be treated not requiring preparation

◉ the existing technological openings should be closed after use with a rubber seal

◎ existing technological openings are not sealed after use

◍ drillholes with a diameter of 14 mm, after use must be sealed with a rubber stopper

Note: The following preparations should be used for maintenance: Items 1 to 35 - Preservatives to protect enclosed spaces (Table 6-8). part 36-43 - Preservatives for the protection of the chassis and lower body panels (Table 6-7). pos. 44 - wax pastes for the maintenance of lacquered body surfaces (Table 6-6).

6.9. Table: VEHICLE ANTI-CORROSION TECHNOLOGY

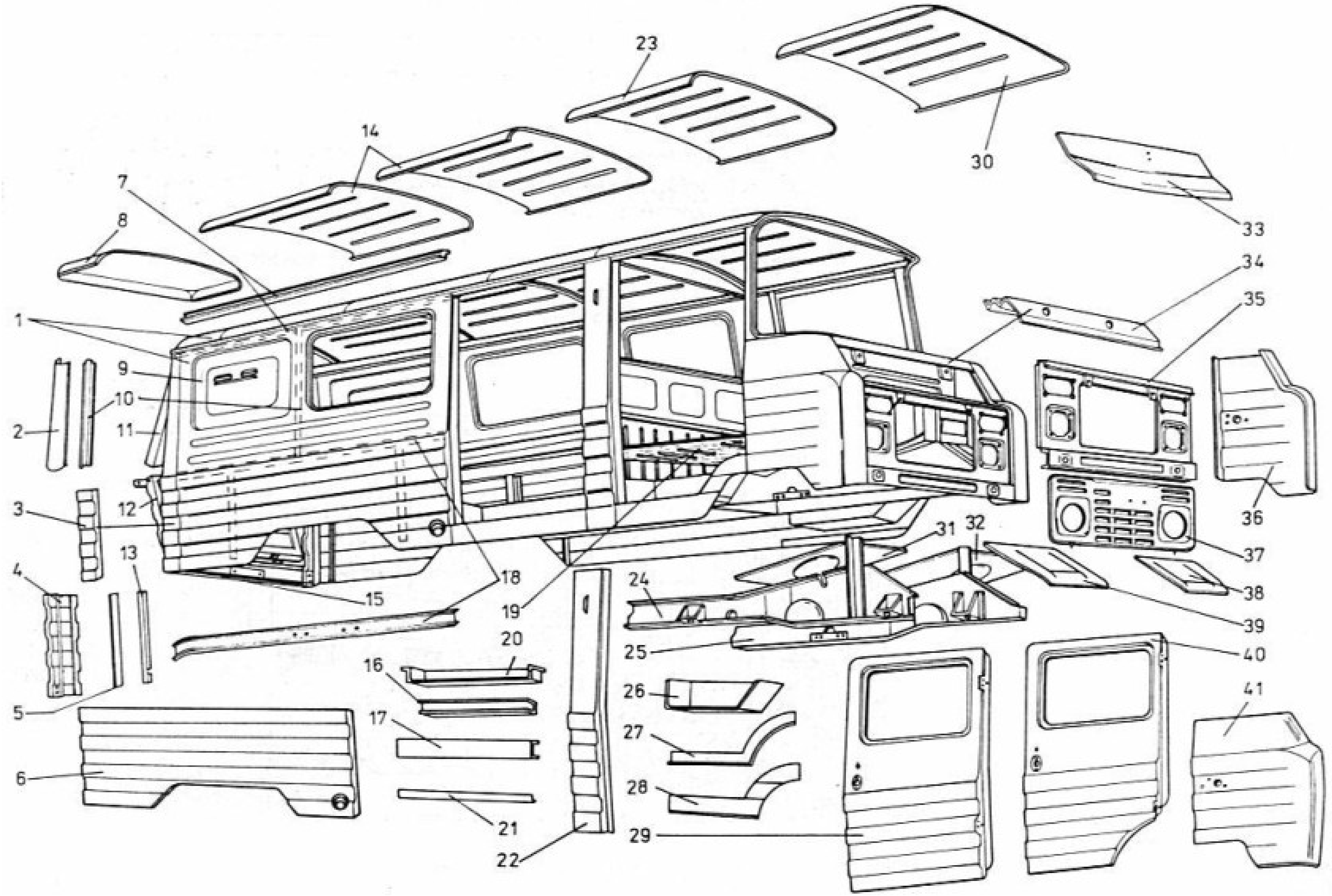
■ Removable parts, such as doors and front covers of the cab, are replaced with new ones in case of major damage (primed). A major problem is the repair of cabin or bodywork shells that are fully welded together.

In such cases, it is best to have your vehicle repaired. The repair then involves cutting out the damaged cover and welding in place of the new or made parts. The range of covers to be replaced depends not only on the size of the damage, but also on the nature of the damage to the parts. Knowing the structure of the body, its load-bearing and functionally important elements, as well as the method of their connection (see Fig. 6.4 and 6.42) will allow for a correct assessment of the scope of the replaced parts and a decision on the method of repair.

A list of extrusions of the car body A07 manufactured for spare parts is given in Table 6-10.

In case of damage to movable parts of the cabin or the body, such as doors, covers and covers, replacement is recommended if the cost of repair without assembly work exceeds 70% of the cost of purchasing a new part.

6.7.3 Body repair



6.7.3 Body repair

	Part number	Description	
1	17-5000485	Bodywork A07 pcs.	*Nadwozie A07 kpl.*
2	L05-8504094	Upper-right rear corner	*Narożnik tylny górny-prawy*
2	L05-8504090	Upper-left rear corner	*Narożnik tylny górny-lewy*
3	L05-8504090	Rear right corner	*Narożnik tylny prawy*
3	LO3-8502484	Rear right corner	*Narożnik tylny prawy*
4	LO5-8505090	Rear left corner	*Narożnik tylny lewy*
4	LO3-8502483	Rear left corner	*Narożnik tylny lewy*
5	LO5-8504097	Cover plate	*Nakładka poszycia*
6	LO3-8504086	Side wall platform right	*Plat ściany bocznej prawy*
6	LO5-8505086	Sidewall platform left	*Plat ściany bocznej lewy*
6	LO3-8502078-1	Right wall platform	*Plat ściany prawy*
6	LO3-8502077	Wall panels left	*Plat ściany lewy*
7	LO5-8504036	Wall beam right ppl.	*Belka ściany prawej kpl.*
8	LO5-5702023	Roof panel	*Część tylna dachu*
9	LO5-8504088	Top panel of the right side wall sheathing	*Płat górny poszycia ściany bocznej prawy*
10	LO5-8504053	Upper pillar of the sidewall skeleton	*Słupek górny szkieletu ściany bocznej*
11	LO5-6301102	Upper door leaf of the rear door	*Skrzydło górne drzwi tylnych*
12	LO3-8503012	The rear wall of the load platform. - ppl.	*Ściana tylna skrzyni ładunk. - kpl.*
13	LO3-8502032	The loading platform post of the centre left-hand wall - flange.	*Słupek skrzyni ładunkowej środkowej ściany lewej - kpl.*
14	LO5-5702021	Roof centre section	*Część środkowa dachu*
15	LO3-8503138	Tailored rear box	*Płat tylny skrzyni ładunkowej*
16	LO5-8504030	Floor beam for side doors	*Belka podłogowa drzwi bocznych*
17	L05-8504098	Exterior floor coverings for side doors	*Poszycia zewnętrzne podłogowe drzwi bocznych*
18	LO5-8504050	The right sidewall sidewall sidewall string - ppl.	*Podłużnica ściany bocznej prawej - kpl.*
19	17-5101063	Cabin floor panelling	*Płat podłogi kabiny*
20	L05-8504032	Degree of the side door of the van	*Stopień drzwi bocznych furgonu*
21	LO5-8504099	Floor reinforcement for side doors	*Wzmocnienie podłogowe drzwi bocznych*
22	KO3-5401032-2	Rearpost sheathing right ppl.	*Poszycie słupka tylnego kpl. prawe*
22	KO3-540131-2	Rear post sheathing left ppl.	*Poszycie słupka tylnego kpl. lewe*
23	LO5-5702020-1	Front part of roof	*Część przednia dachu*
24	17-5101150	Carrier wall right ppl.	*Ściana nośna prawa kpl.*
25	17-5101141	Load-bearing wall left ppl.	*Ściana nośna lewa kpl.*
26	KO3-5101028-2	Right cab step	*Stopień kabiny prawy*
26	KO3-5101027-2	Degree of cab left	*Stopień kabiny lewy*
27	17-5105171	Bottom beam Left bottom beam	*Belka dolna kpl. lewa*
27	17-5104170	Lower beam, right ppl	*Belka dolna kpl. prawa*
28	17-5104070	Sheathing of the bottom right beam ppl.	*Poszycie belki dolnej prawej kpl.*
28	17-5105071	Covering of the left bottom beam ppl.	*Poszycie belki dolnej lewej kpl.*
29	17-6201130	Side doors of the van ppl.	*Drzwi boczne furgonu kpl.*
30	17-5107020	Cabin roof	*Dach kabiny*
30	17-5107010	Cabin roof	*Dach kabiny*
31	17-5101120	Right footrest ppl.	*Podnóżek prawy kpl.*
32	17-5101121	Footrest left ppl.	*Podnóżek lewy kpl.*
33	17-6901020	Front cover ppl.	*Pokrywa przednia kpl.*
34	17-5100042	Cabin flush-mounted beams	*Belka podokienna kabiny*
35	17-5101570	Front platform ppl.	*Plat przedni kpl.*
36	17-5100061	Front right corner	*Narożnik przedni prawy*
36	17-5100058	Front right corner	*Narożnik przedni prawy*
37	17-6901220	Air inlet cover ppl.	*Osłona wlotu powietrza kpl.*
38	17-5101363	Front left mudguard	*Błotnik przedni lewy*
39	17-5101362	Front mudguard, right	*Błotnik przedni prawy*
40	17-6101130	Cabin door ppl. - righteous	*Drzwi kabiny kpl. - prawe*
40	17-6101131	Cabin door ppl. - left	*Drzwi kabiny kpl. - lewe*
41	17-5100063	Front left corner	*Narożnik przedni lewy*
41	17-5100059	Front left corner	*Narożnik przedni lewy*

6.10. Table: BODYWORK COMPONENTS

6.7.3 Body repair

■ The cabin must be scrapped if it is present:

- bends, deformations and damage to components which cannot be removed by straightening,
- far-reaching corrosion of load-bearing walls, floors and knots where the door posts are bonded to the floor (when the depth of pits exceeds 1/3 of the sheet thickness).

If the degree of wear and tear is lower and the cost of repair does not exceed 60...70% of the cost of purchasing a new cabin or bodywork, these units must be repaired.

Type of damage	Method of repair
1. Corrosion perforation with a small number of punctures, having a local character	1. Brazing or filling of cavities with epoxy resin
2. Corrosion perforation with a very high concentration of punctures, causing larger areas of the sheet to fall out and, as a result, the formation of large holes.	2. Inserting a new body section or batten
3. Corrosion cracks in sheets, mostly floors	3. Welding, brazing or cutting and inserting of a new part
4. Corrosion damage to welds, usually located in corners of plates or recesses	4. crack-welding or pad-welding
5. Corrosion damage to welded joints which are difficult to protect against corrosion	5. Welding or welding in damaged areas
6. Small dents in the side wall or door panels	6. Fill with tin alloy or putty Epidian 410
7. Cover damaged by rupture	7. Align the dents by denting around the ruptured area, then weld the gap between the acetylene burner and bit No. 1.
8. Dents in the large area of the cover	8. Remove with a screw or hydraulic spreader.
9. Bottom beam damaged by corrosion	9. Cut the threshold with an acetylene burner or a metal ball. Cut the welds with a cutter. Adjust the new threshold and weld all the way around with an acetylene burner. Sand the joint with a grinder and fill the cavities with tin solder or putty Epidian 410.
10. Front corner damaged by corrosion or torn apart	10. Cut the corner lobe with a burner, ball or scissor. Remove the edge left by the cutter and align with the file. Fit a new corner and weld with an acetylene burner or attach by welding at 40 mm intervals. Fill in the gaps in the corner joint with a hard alloy, e.g. LM-63, level and paint the welded and soldered joints.
11 Other body shell components damaged by corrosion or torn apart	11. maintaining the sequence of operations (as in the case of replacing the corner), insert other parts of the body if they are damaged and need to be replaced.

6.11. Table: METHOD OF REPAIR OF CORROSION DAMAGE TO BODYWORK

Corrosion-damaged coverings can be repaired by various methods, the choice depending on the technical possibilities of the plant and the assessment of the individual repairer. A summary of the damage to the bodywork and the means of its repair are given in Table 6-11.

The following bodywork components are most exposed to corrosion: front corners, substructure and reinforcement, cab floor (especially in corners near the rear wall), side walls (in the lower part), bottom sheathing. Welding must be carried out using an acetylene burner. Hard soldering requires fluxes that protect the soldered surface from oxidation and dissolve oxides on the surface of the sheet. Borax or a mixture of borax, chlorides and sodium fluorides are used as fluxes.

6.7.3 Body repair

Welding thin sheets is very difficult and requires a lot of experience.

Evening out dents is less time-consuming and easier with a joint compound such as Epidicate 410, starting by preparing the surface of the sheet. This action has a fundamental influence on the hardness (adhesion) of the applied layer of mastic. The surface of the coating to be coated with putty should be prepared as follows:

- remove the old lacquer coating and rust by mechanical means until the metallic surface of the sheet is obtained,
- increase the roughness of the surface with a file or scraper,
- remove dust and degrease the surface with extraction gasoline or nitro solvent.

On the surface prepared in such a way, which should not be touched with bare hands. kami, a layer of prepared joint compound should be applied. This preparation consists in mixing the putty with a hardener, which is added 6-8% (by mass). Mix the two components very carefully and only prepare as much mastic as is needed for the bodywork to be repaired. It takes 10 hours for the Epidicate layer to harden at 18°C, but only 30 minutes at 80°C. The hardened layer of Epidicate can be perfectly processed with locksmith tools such as files, grinders, abrasive cloth, etc.

Special care should be taken in the process of applying and treating Epidicating, paying attention to proper ventilation of the rooms, as both Epidian 410 putty, which is produced on the basis of epoxy resin, and hardener Z1 are harmful to health.

6.7.4 Renovation painting

After all bodywork sheet metal repairs, the damaged areas must be protected with a varnish coating. The Autorenolak-F refurbishment enamel is used for this purpose. This enamel is applied to a suitably prepared substrate, i.e. primed or mudded and levelled by sanding.

The old coating is sanded with waterproof abrasive paper to expose the "healthy layer" of enamel and, if necessary, to metal. Wet sanding should be carried out by dampening the areas to be ground with water. Corroded areas are polished to remove the corrosion completely. After sanding, the repaired area is washed with water, left to dry completely, and then covered with a layer of modified phthalic primer "Autokor", symbol 3231-006-110. After 24 hours of drying of the substrate, the primed areas should be sanded again with abrasive paper, washed and dried. Then a thin so called "spray" is applied to the surface of the body. the 'call' enamel layer, which is the control layer. All defects, which are difficult to grasp with the naked eye, such as cavities, scratches, unevenness, etc., are visible on this surface.

After the enamel has dried up completely, it is covered with oil putty with the symbol 2241-361-XXX. When the putty is dry, it is sanded with abrasive paper. The ground areas are washed with a flange moistened with petrol, and after 5 minutes two layers of Autorenolak-F enamel are applied to the surface prepared in this way in about 20 minutes.

These enamels can be dried at a temperature of about 80°C or 20°C. The coating is dried at 80°C, giving full mechanical resistance immediately, and dried at 20°C, after about 10 days. Autorenolak-F Renovation enamels should be diluted with 8124-361-000 phthalic carbide thinner.

6.7.4 Renovation painting

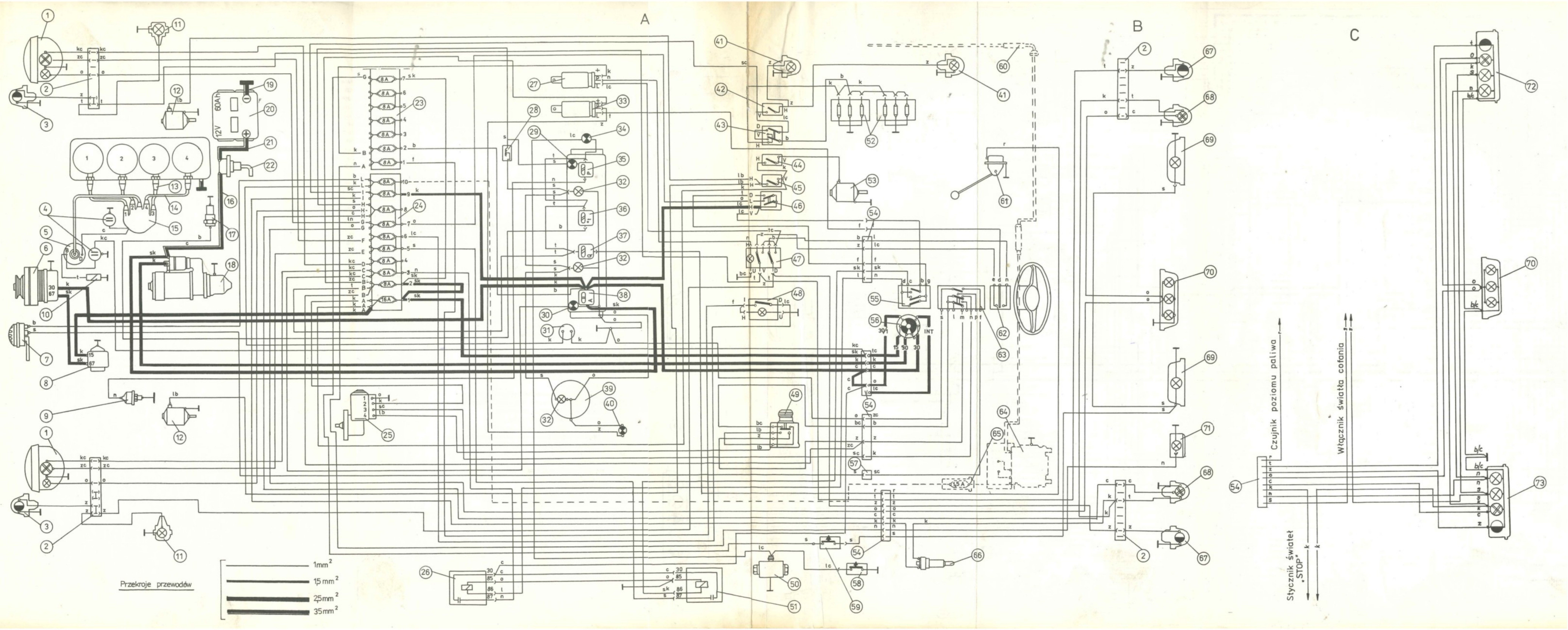
The cab floor on the underside and the side walls of the box of van-type vehicles on the inside - should be maintained with Bitex, after priming with an anticorrosive primer, e.g. penetrol, autochronous or zinc phosphate. Bitex shall be applied in a layer approximately 2,0 mm thick (twice by spraying).

7ELECTRICAL SETUP

Żuk is equipped with a single wire electrical system with a nominal voltage of 12 V; the other wire (pole) is the car's weight.

Electrical diagrams of Żuk cars are shown in the drawings:

- Figure 7.1 AB - vans,
- Figure 7.1 AC - pickup (A111, A161 - differential diagram),
- Figure 7.2 - container and isothermal cars,
- Figure 7.3 - fire-fighting vehicles,
- Figure 7.3a - Żuk cars with 4C90 engine (differential diagram).



A - the basic part of the electrical installation (common for all variants),
B - rear part of the van-type vehicle installation,
C - rear part of the pickup-type installation.
1 - headlamp (60/55 W),
2 - plug connector,
3 - front lamp of the front direction indicator lamp and the hazard warning signal (21 W),
4 - interference suppression capacitor,
5 - ignition coil 4220,
6 - alternator A124F2 (14 V ~ 44 A = 616 W),
7 - beep (50 W),
8 - voltage regulator RC2/12D,
9 - oil pressure sensor in the CCO-WS engine,
10 - carburetor solenoid valve,
11 - side direction indicator lamp,
12 - heater motor (8 W),
13 - spark plugs (F75),
14 - ignition cables,
15 - ignition distributor type (44-44),
16 - cable: battery disconnect device - starter,
17 - motor temperature sensor,
18 - R5c starter (1.5 kW),
19 - battery cable - ground,
20 - 6SE6OTM rechargeable battery (12 V, 60 A.h),
21 - cable: battery - disconnect device,
22 - battery disconnect device,
23 - fuse box (additional),
24 - fuse box,
25 - windscreen wiper motor,
26 - main-beam headlamp relay,
27 - Interrupter of hazard warning signal,
28 - Display panel lighting adjuster,
29 - position lamp tell-tale, green (2 W),
30 - main-beam headlamp tell-tale, blue (2 W).
31 - portable lamp socket,
32 - Speedometer lights and indicator boards,
33 - direction indicator light interrupter,
34 - warning light (red) for brake failure or application of the parking brake,
35 - engine oil pressure gauge,
36 - motor temperature indicator,
37 - fuel level indicator,
38 - charging current indicator (ammeter),
39 - speedometer and kilometre counter,
40 - direction indicator lamp green (2 W),
41 - Driver's cabin lighting lamp,
42 - switch for lighting the driver's cab,
43 - passenger compartment lighting switch,
44 - fan switch for passenger compartment heater,
45 - fan switch for the driver's cab heater,
46 - push-button switch for exterior lights,
47 - change-over switch for hazard warning signal with a tell-tale,
48 - rear fog lamp switch with control lamp,
49 - windscreen washer pump,
50 - brake failure indicator,
51 - passing beam relay,
52 - passenger compartment lamps 1,
53 - engine for passenger compartment heater 1,
54 - plug connector,
55 - main-beam headlamp switch,
56 - ignition and starter switch,
57 - plug connector,
58 - push-button switch for the indicator light of the applied parking brake,
59 - reversing lamp switch,
60 - car antenna,
61 - fuel level sensor,
62 - direction indicator switch,
63 - window wiper and sound signal selector switch,
64 - radio receiver,
65 - fuse (1.5 A) in the radio supply cable,
66 - brake light contactor, "stop",
67 - rear lamp of direction indicator lamps and hazard warning signal (21 W),
68 - rear position and braking lamp (21/5 W),
69 - reversing lamp lamp (21 W),
70 - registration plate lamp,
71 - rear fog lamp - red (21 W),
72 - Right composite lamp (21 W and 10 W),
73 - left composite lamp (21 W and 10 W),

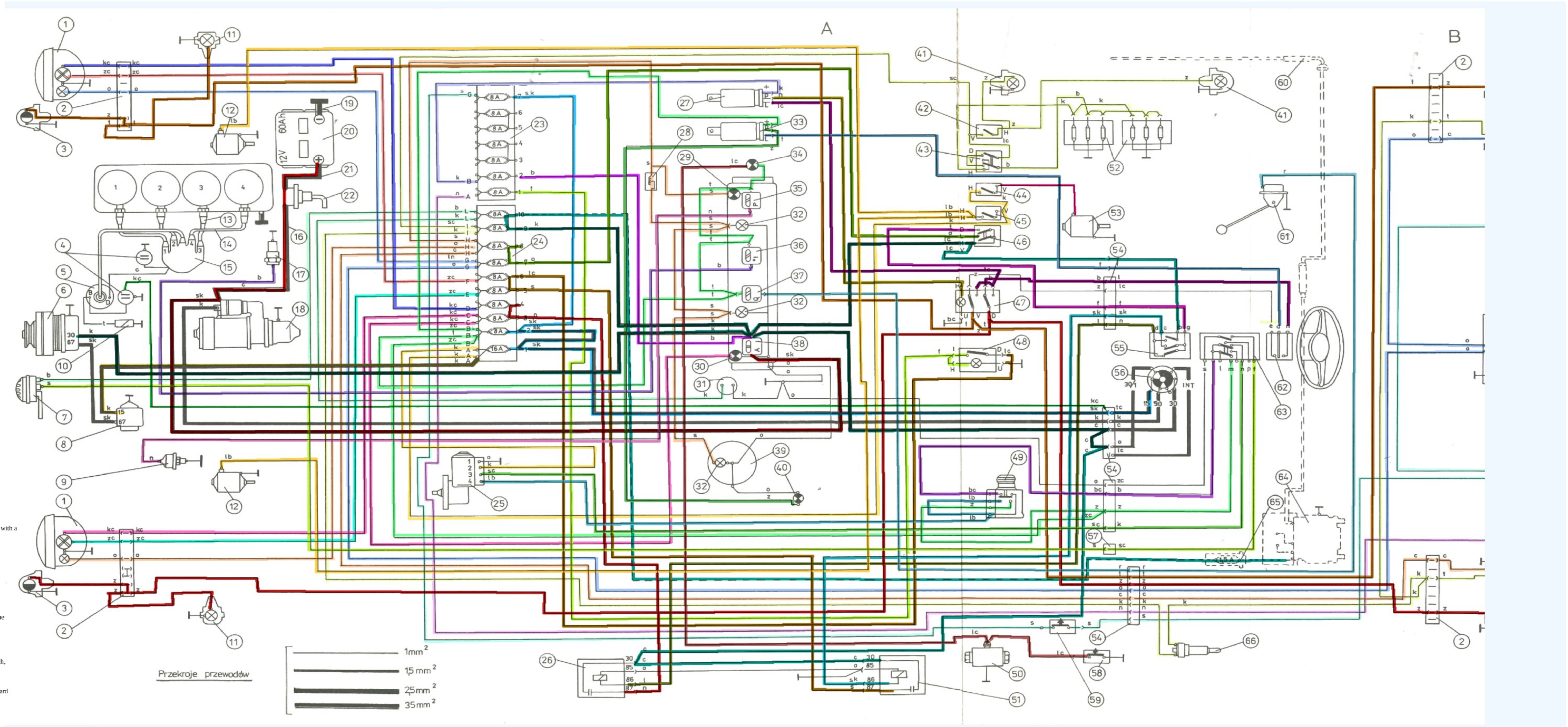
7.1. Figure: ELECTRICAL INSTALLATION DIAGRAM (VAN/PICKUP)

Colours of electric wires:
b - white
c - black
f - violet
k - red
l - light blue
n - blue
o - chestnut
r - pink
s - grey
t - green
z - yellow
bc - white with black
tc - green with black
kc - red with black
lb - blue with black
sc - grey with black
sk - grey with red
zc - yellow with black

A - część podstawowa instalacji elektrycznej (wspólna dla wszystkich odmian,
B - część tylna instalacji samochodu typu furgon,
C - część tylna instalacji samochodów skrzyniowych.
1 - reflektor (60/55 W),
2 - złącze wtykowe,
3 - lampa przednia świateł kierunku jazdy przednie i świateł awaryjnych (21 W),
4 - kondensator przeciwzakłóceniowy,
5 – cewka zapłonowa 4220,
6 - alternator A124F2 (14 V ~ 44 A = 616 W),
7 - sygnał dźwiękowy (50 W),
8 - regulator napięcia RC2/12D,
9 - czujnik ciśnienia oleju w silniku CCO-WS,
10 - elektrozawór gaźnika,
11 - lampka kierunkowskazu bocznego,
12 - silnik nagrzewnicy (8 W),
13 - świece zapłonowe (F75),
14 - przewody zapłonowe,
15 - rozdzielacz zapłonu typ (44-44),
16 - przewód: odłącznik akumulatora - rozrusznik,
17 - czujnik temperatury silnika,
18 - rozrusznik R5c (1,5 kW),
19 - przewód akumulator - masa,
20 - akumulator 6SE6OTM (12 V, 60 A.h),
21 - przewód: akumulator - odłącznik,
22 - odłącznik akumulatora,
23 - skrzynka bezpieczników (dodatkowa),
24 - skrzynka bezpieczników,
25 – silnik wycieraczki szyby,
26 - przekaźnik świateł drogowych,
27 - przerywacz świateł awaryjnych,
28 - regulator oświetlania tablicy wskaźników,
29 - lampka kontrolna świateł pozycyjnych, zielona (2 W),
30 - lampka kontrolna świateł drogowych, niebieska (2 W).
31 - gniazdo wtykowe lampy przenośnej,
32 - lampki oświetlenia prędkościomierza i tablicy wskaźników,
33 - przerywacz świateł kierunku jazdy,
34 - lampka kontrolna (czerwona) uszkodzenia hamulców lub włączonego hamulca postojowego,
35 - wskaźnik ciśnienia oleju w silniku,
36 - wskaźnik temperatury silnika,
37 - wskaźnik poziomu paliwa,
38 - wskaźnik prądu ładowania (amperomierza),
39 - prędkościomierz i licznik kilometrów,
40 - lampka kontrolna świateł kierunku jazdy, zielona (2 W),
41 - lampa oświetlenia kabiny kierowcy,
42 - włącznik oświetlenia kabiny kierowcy,
43 - włącznik oświetlenia przedziału pasażerskiego,
44 - włącznik wentylatorów nagrzewnicy przedziału pasażerskiego,
45 - włącznik wentylatorów nagrzewnicy kabiny kierowcy,
46 – włącznik klawiszowy świateł zewnętrznych,
47 - przełącznik świateł awaryjnych z lampką kontrolną,
48 - wyłącznik lampy tylnej przeciwmgłowej z lampką kontrolną,
49 - pompa spryskiwacza szyby,
50 - sygnalizator uszkodzenia hamulców,
51 - przekaźnik świateł mijania,
52 - lampy oświetlenia przedziału pasażerskiego 1,
53 - silnik nagrzewnicy przedziału pasażerskiego 1,
54 - złącze wtykowe,
55 - przełącznik świateł drogowych,
56 – wyłącznik zapłonu i rozrusznika,
57 – złącze wtykowe,
58 - włącznik przyciskowy lampki kontrolnej włączonego hamulca postojowego,
59 - włącznik świateł cofania,
60 - antena samochodowa,
61 – czujnik poziomu paliwa,
62 - przełącznik świateł kierunku jazdy,
63 - przełącznik wycieraczki szyby i sygnału dźwiękowego,
64 - odbiornik radiowy,
65 - bezpiecznik (1,5 A) w przewodzie zasilającym radio,
66 - stycznik światła hamowania „stop”,
67 – lampa tylna świateł kierunku jazdy i świateł awaryjnych (21 W),
68 - lampa tylnych świateł pozycyjnych i hamowania (21/5 W),
69 - lampa świateł cofania (21 W),
70 - lampa oświetlenia tablicy rejestracyjnej,
71 - lampa tylna przeciwmgłowa - czerwona (21 W),
72 - lampa zespolona prawa (21 W i 10 W),
73 - lampa zespolona lewa (21 W i 10 W),

Kolory przewodów elektrycznych:
b - biały
c - czarny
f - fioletowy
k - czerwony
l - jasnobłękitny
n - niebieski
o – kasztanowy
r - różowy
s - szary
t - zielony
z - żółty
b/c - biały z czarnym
t/c - zielony z czarnym
k/c - czerwony z czarnym
1/b - błękitny z czarnym
s/c - szary z czarnym
s/k – szary z czerwonym
z/c - żółty z czarnym

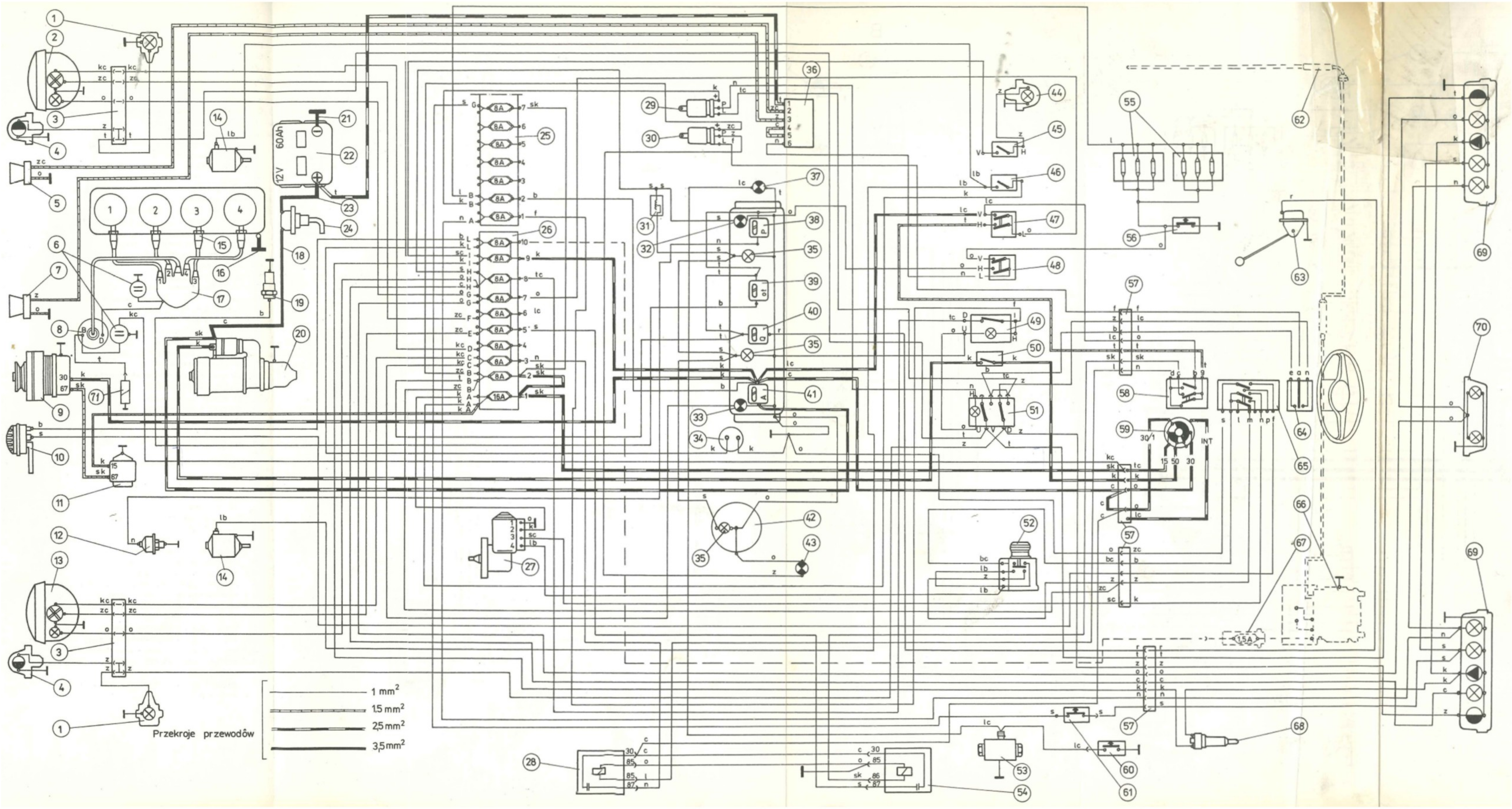
24	A - 1 16A	Heater fan motors (left and right) *Silniki wentylatorów nagrzewnic (lewej i prawej)* Wiper motor *Silnik napędu wycieraczki* Voltage regulator *Regulator napięcia*
	B - 2	Direction-indicator lamps (front and rear) *Lampy kierunkowskazów (przednich i tylnych)* Direction-indicator dashboard lamps *Lampki sygnalizacyjne kierunkowskazów* Fuel gauge indicator and sensor *Wskaźnik i czujnik poziomu paliwa* Motor temperature indicator and sensor *Wskaźnik i czujnik temperatury silnika* Oil pressure gauge and sensor *Wskaźnik i czujnik ciśnienia oleju*
	C - 3	Left headlamp - main-beam headlamp *Lewy reflektor - światło drogowe*
	D - 4	Right headlamp - main-beam headlamp *Prawy reflektor – światło drogowe* Main beam dashboard lamps *Lampka sygnalizacyjna świateł drogowych*
	E - 5	Left hand headlamp - dipped-beam *Lewy reflektor - światło mijania*
	F - 6	Right hand headlamp - dipped-beam *Prawy reflektor - światło mijania*
	G - 7	Right position (front and rear) lamp *Prawe światło pozycyjne (przednie i tylne)* Registration number plate lamp *Lampa oświetlenia tablicy numeru rejestracyjnego*
	H - 8	Left position (front and rear) lamp *Lewe światło pozycyjne (przednie i tylne)* Dashboard lights *Lampki oświetlenia tablicy wskaźników*
	I - 9	Stop/brake lamp light *Światła hamowania „Stop"* Cabin/interior lighting lamps *Lampy oświetlenia wnętrza kabiny i skrzyni ładunkowej*
	L - 10	Horn *Sygnał dźwiękowy* Plug-in socket for portable lamp *Gniazdo wtykowe lampy przenośnej*
23	A” - 1”	Rear fog light *Światła przeciwmgłowy tylne*
	B” - 2”	Hazard-warning lights *Światła awaryjne*
	G” - 7”	*Reverse light* *Światła cofania*



7.1.extra Figure: *COLORED ELECTRICAL INSTALLATION DIAGRAM WITH FUSEBOXES DESCRIPTION*

1 - headlamp (60/55 W),
2 - plug connector,
3 - front lamp of the front direction indicator lamp and the hazard warning signal (21 W),
4 - interference suppression capacitor,
5 - ignition coil 4220,
6 - alternator A124F2 (14 V ~ 44 A = 616 W),
7 - beep (50 W),
8 - voltage regulator RC2/12D,
9 - oil pressure sensor in the CCO-WS engine,
10 - carburetor solenoid valve,
11 - side direction indicator lamp,
12 - heater motor (8 W),
13 - spark plugs (F75),
14 - ignition cables,
15 - ignition distributor type (44-44),
16 - cable: battery disconnect device - starter,
17 - motor temperature sensor,
18 - R5c starter (1.5 kW),
19 - battery cable - ground,
20 - 6SE6OTM rechargeable battery (12 V, 60 A.h),
21 - cable: battery - disconnect device,
22 - battery disconnect device,
23 - fuse box (additional),
24 - fuse box,
25 - windscreen wiper motor,
26 - main-beam headlamp relay,
27 - Interrupter of hazard warning signal,
28 - Display panel lighting adjuster,
29 - position lamp tell-tale, green (2 W),
30 - main-beam headlamp tell-tale, blue (2 W).
31 - portable lamp socket,
32 - Speedometer lights and indicator boards,
33 - direction indicator light interrupter,
34 - warning light (red) for brake failure or application of the parking brake,
35 - engine oil pressure gauge,
36 - motor temperature indicator,
37 - fuel level indicator,
38 - charging current indicator (ammeter),
39 - speedometer and kilometre counter,
40 - direction indicator lamp green (2 W),
41 - Driver's cabin lighting lamp,
42 - switch for lighting the driver's cab,
43 - passenger compartment lighting switch,
44 - fan switch for passenger compartment heater,
45 - fan switch for the driver's cab heater,
46 - push-button switch for exterior lights,
47 - change-over switch for hazard warning signal with a tell-tale,
48 - rear fog lamp switch with control lamp,
49 - windscreen washer pump,
50 - brake failure indicator,
51 - passing beam relay,
52 - passenger compartment lamps 1,
53 - engine for passenger compartment heater 1,
54 - plug connector,
55 - main-beam headlamp switch,
56 - ignition and starter switch,
57 - plug connector,
58 - push-button switch for the indicator light of the applied parking brake,
59 - reversing lamp switch,
60 - car antenna,
61 - fuel level sensor,
62 - direction indicator switch,
63 - window wiper and sound signal selector switch,
64 - radio receiver,
65 - fuse (1.5 A) in the radio supply cable,
66 - brake light contactor, "stop",
67 - rear lamp of direction indicator lamps and hazard warning signal (21 W),
68 - rear position and braking lamp (21/5 W),
69 - reversing lamp lamp (21 W),
70 - registration plate lamp,
71 - rear fog lamp - red (21 W),
72 - Right composite lamp (21 W and 10 W),
73 - left composite lamp (21 W and 10 W),

Colours of electric wires:
b - white
c - black
f - violet
k - red
l - light blue
n - blue
o - chestnut
r - pink
s - grey
t - green
z - yellow
bc - white with black
tc - green with black
kc - red with black
lb - blue with black
sc - grey with black
sk - grey with red
zc - yellow with black



7.2. Figure: ELECTRICAL INSTALLATION DIAGRAM (CONTAINER CARS)

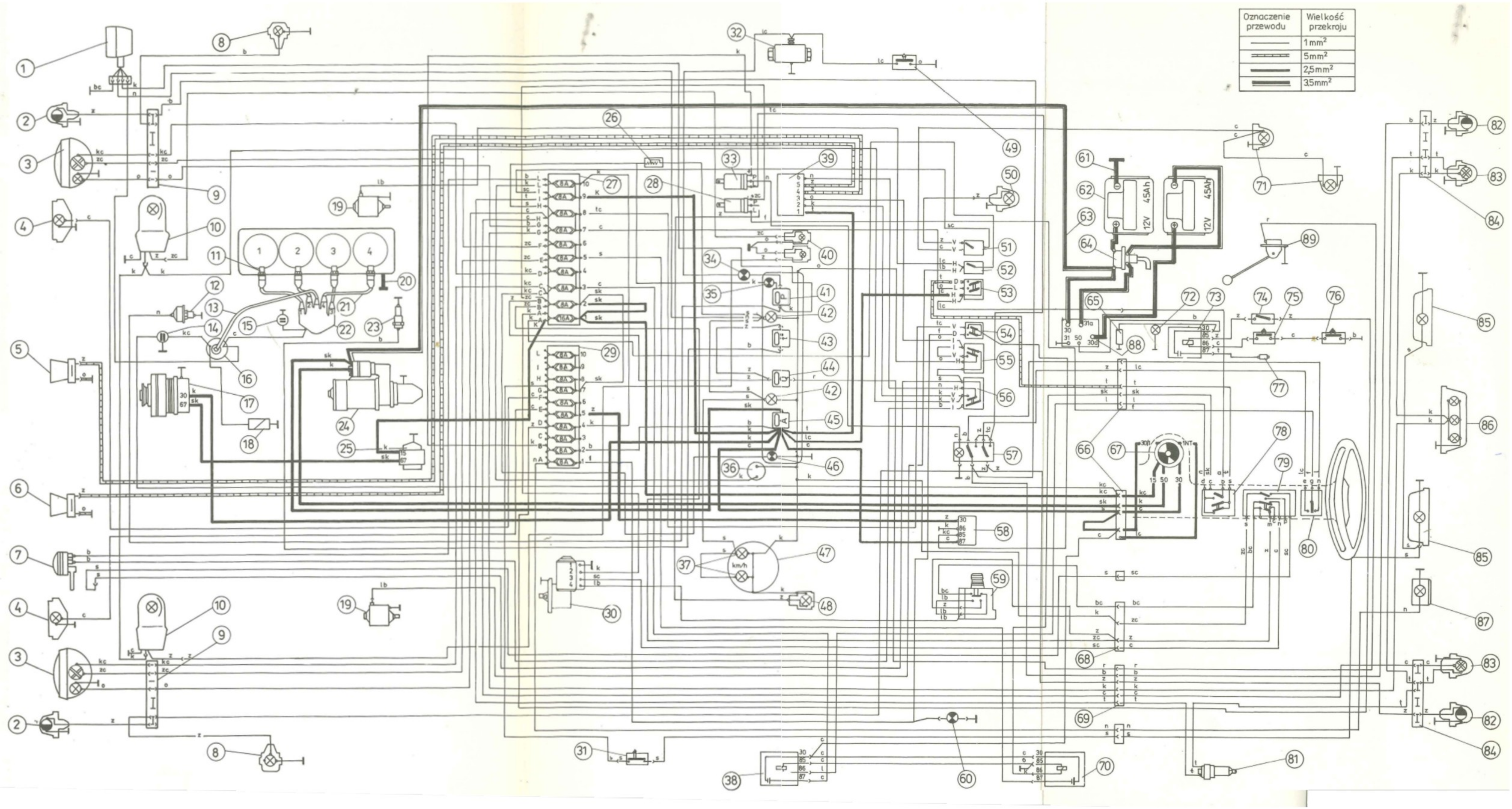
Colours of electric wires:
b - white
c - black
f - violet
k - red
l - light blue
n - blue
o - chestnut
r - pink
s - grey
t - green
z - yellow
bc - white with black
tc - green with black
kc - red with black
lb - blue with black
sc - grey with black
sk - grey with red
zc - yellow with black

1 - side direction indicator lamp,
2 - right hand headlamp 55/60 W + position lamp 4 W,
3 - plug-in + push-in connector,
4 - front direction indicator lamps and hazard warning signal lamps,
5 - bass *,
6 - capacitor,
7 - tweeter *,
8 - ignition coil (12V/15kV),
9 - alternator A124F2 (616 W),
10 - beep (50 W),
11 - voltage regulator Rc2/12D,
12 - oil pressure sensor,
13 - left-hand lamp 55/60 W + position lamp 4 W,
14 - heater fan motors,
15 - spark plugs F75 "Ispra",
16 - ribbon cable motor/bodywork weight,
17 - ignition apparatus (44-44/IV),
18 - cable from battery disconnector to starter,
19 - motor temperature sensor,
20 - R5c starter (12V, 1.5kW),
21 - cable from battery to ground,
22 - 6SE6OTM starter battery,
23 - cable from battery to disconnect device,
24 - battery disconnect SW-40,
25 and 26 - fuse box,
27 - windscreen wiper motor (36 W),
28 - main-beam headlamp relay (T-5170),
29 - Interrupter of hazard warning signal,
30 - direction indicator breaker,
31 - indicator board lighting intensity control,
32 - position lamp tell-tale (green),
33 - main-beam headlamp tell-tale (blue),
34 - portable lamp socket,
35 - indicator light,
36 - signal converter (only for A172B),
37 - warning light (red) for failure of the service brake or parking brake application,
38 - engine oil pressure gauge,
39 - motor temperature indicator,
40 - tank level indicator,
41 - charging current indicator,
42 - Speedometer,
43 - direction indicator lamp (green),
44 - cab illumination lamp,
45 - cabin lighting switch,
46 - switch for fans of cabin heaters,
47 - exterior light switch,
48 - double tone signal switch *,
49 - rear fog lamp switch,
50 - start lock switch *,
51 - key switch for hazard warning signal,
52 - windscreen washer pump,
53 - brake failure indicator,
54 - passing beam relay (T-5170),
55 - container interior lighting lamps,
56 - light door switch,
57 - plug connector,
58 - main-beam headlamp switch,
59 - ignition and starter switch,
60 - parking brake control indicator switches,
61 - reversing lamp switch,
62 - car antenna (ASP-02),
63 - fuel level sensor in the tank,
64 - direction indicator switch,
65 - Switch for windscreen wiper or sound signal,
66 - 'Safari-2' radio-broadcast receiver (5W),
67 - fuse (1.5 A) in the radio cable,
68 - brake light contactor,
69 - grouped rear lamp,
70 - registration plate lamp,
71 - carburetor solenoid valve
* Only for the A 172B.

Colour coding of electric wires as shown in Figure 7.1.

1 - lampka kierunkowskazu bocznego,
2 - reflektor prawy 55/60 W + światło pozycyjne 4 W,
3 - złącze wtykowe + krotne,
4 - lampy świateł kierunku jazdy przednie i świateł awaryjnych,
*5 - sygnał niskotonowy *,*
6 - kondensator,
*7 - sygnał wysokotonowy *,*
8 - cewka zapłonowa (12V/15 kV),
9 - alternator A124F2 (616 W),
10 - sygnał dźwiękowy (50 W),
11 – regulator napięcia Rc2/12D,
12 – czujnik ciśnienia oleju,
13 – reflektor lewy 55/60 W + światła pozycyjne 4 W,
14 - silniczki wentylatorów nagrzewnic,
15 - świece zapłonowe F75 "Iskra",
16 - przewód taśmowy masa silnika-nadwozie,
17 - aparat zapłonowy (44-44/IV),
18 - przewód od odłącznika akumulatora do rozrusznika,
19 – czujnik temperatury silnika,
20 - rozrusznik R5c (12V, 1,5 kW),
21 – przewód od akumulatora do masy,
22 - akumulator rozruchowy 6SE6OTM,
23 - przewód od akumulatora do odłącznika,
24 - odłącznik akumulatora SW-40,
25 i 26 - skrzynka bezpieczników,
27 - silnik wycieraczki szyby (36 W),
28 - przekaźnik świateł drogowych (T-5170),
29 - przerywacz świateł awaryjnych,
30 - przerywacz świateł kierunku jazdy,
31 – regulator intensywności oświetlenia tablicy wskaźników,
32 - lampka kontrolna świateł pozycyjnych (zielona),
33 - lampka kontrolna świateł drogowych (niebieska),
34 - gniazdo wtykowe lampy przenośnej,
35 - lampka oświetlenia wskaźników,
36 - przemiennik sygnałów (tylko dla A172B),
37 - lampka kontrolna (czerwona) uszkodzenia hamulca roboczego lub włączonego hamulca postojowego,
38 - wskaźnik ciśnienia oleju w silniku,
39 - wskaźnik temperatury silnika,
40 - wskaźnik poziomu paliwa w zbiorniku,
41 - wskaźnik prądu ładowania,
42 - prędkościomierz,
43 - lampka kontrolna świateł kierunku jazdy (zielona),
44 - lampka oświetlenia kabiny,
45 - włącznik oświetlenia kabiny,
46 - włącznik wentylatorów nagrzewnic kabiny,
47 - włącznik świateł zewnętrznych,
*48 - włącznik sygnałów dwutonowych *,*
49 - włącznik lampy tylnej przeciwmgłowej,
*50 - włącznik blokady rozruchu *,*
51 - włącznik klawiszowy świateł awaryjnych,
52 – pompa spryskiwacza szyby,
53 - sygnalizator uszkodzenia hamulców,
54 – przekaźnik świateł mijania (T-5170),
55 - lampy oświetlenia wnętrza kontenera,
56 – wyłącznik drzwiowy świateł,
57 - złącze wtykowe,
58 - przełącznik świateł drogowych,
59 – włącznik zapłonu i rozrusznika,
60 - włączniki lampki kontrolnej hamulca postojowego,
61 - włącznik świateł cofania,
62 - antena samochodowa (ASP-02),
63 - czujnik poziomu paliwa w zbiorniku,
64 - przełącznik świateł kierunku jazdy,
65 - przełącznik wycieraczki szyby lub sygnału dźwiękowego,
66 - odbiornik radiowy "Safari-2" (5W),
67 - bezpiecznik (1,5 A) w przewodzie radia,
68 - stycznik światła hamowania,
69 - lampa tylna zespolona,
70 - lampka oświetlenia tablicy rejestracyjnej,
71 - elektrozawór gaźnika
** tylko dla A 172B.*

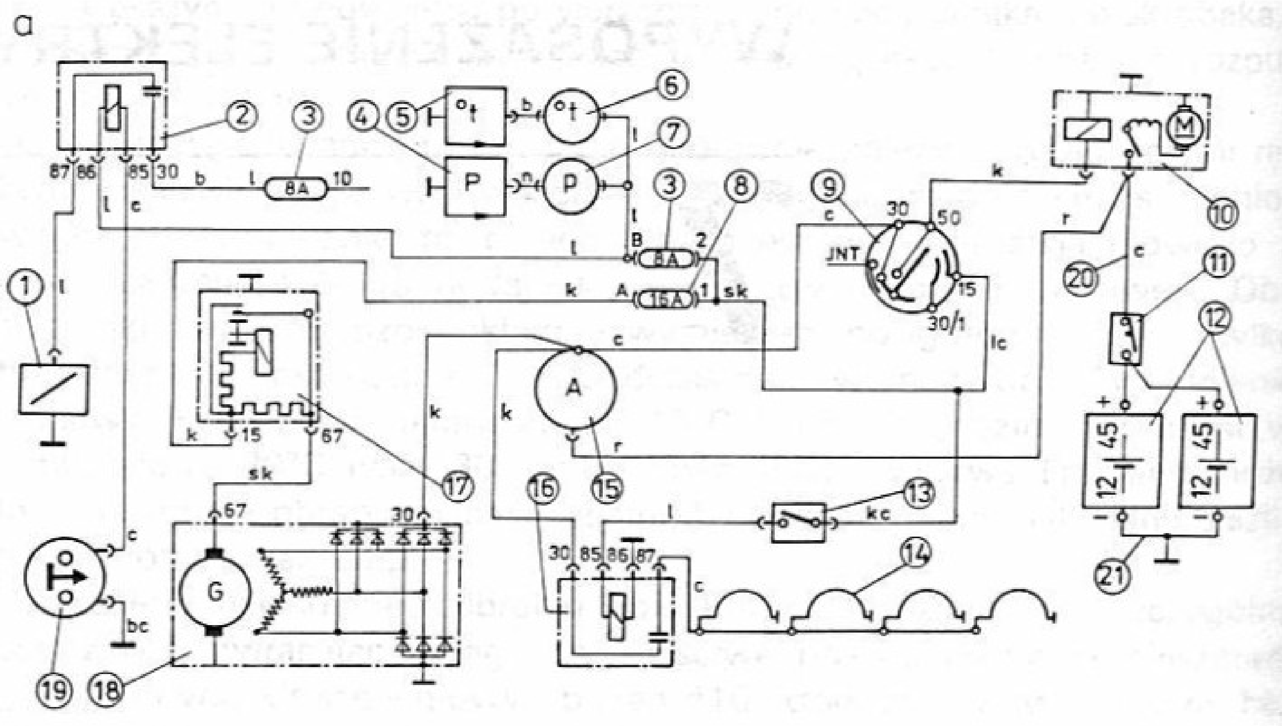
Oznaczenie kolorów przewodów elektrycznych jak na rysunku 7.1



7.3. Figure: ELECTRICAL INSTALLATION DIAGRAM FOR FIRE-FIGHTING VEHICLES

1 - tachometer MS-2 auto-pump,
2 - direction-indicator lamps on the front,
3 - headlamps,
4 - halogen anti-fog (55 W) lamps,
5 - bass signal,
6 - tweeter signal,
7 - beep (12 V, 50 W),
8 - side direction indicator lamp,
9 - plug connector,
10 - Flashlights,
11 - spark plug 4F75),
12 - engine oil pressure sensor,
13 - high voltage coil-distributor cable,
14 - interference suppression capacitor for radio reception,
15 - capacitor 022 ME BN-76/3682-04,
16 - ignition coil (12 V and 15 kV),
17 - alternator 124F2 (14 V x 44 A=616 W),
18 - solenoid valve,
19 - heater fan motor (8 W),
20 - engine earth cable,
21 - ignition cable,
22 - ignition apparatus (44-44).
23 - motor temperature sensor,
24 - R5c starter 1,5 kW,
25 - voltage regulator Re2/12D,
26 - whiteboard intensity control
indicators,
27 - additional fuse box,
28 - direction indicator light interrupter,
29 - fuse box,
30 - windscreen wiper motor,
31 - button switch for reversing lamp,
32 - service brake failure indicator (hydraulic),
33 - Interrupter of hazard warning signal
34 - warning light (red) for failure of the service brake or application of the emergency brake (parking brake),
35 - position lamp tell-tale (green),
36 - portable lamp socket,
37 - Speedometer lights,
38 - main-beam headlamp relay,
39 - sound signal relay (PS-1),
40 - Flash lights (yellow),
41 - engine oil pressure gauge,
42 - indicator lights,
43 - motor temperature indicator,
44 - fuel level indicator,
45 - charging current indicator,
46 - main-beam headlamp tell-tale (blue),
47 - Speedometer with kilometre counter,
48 - direction indicator lamp (green),
49 - push-button switch for the indicator light of the emergency (parking) brake activated,
50 - cabin lighting lamp (10 W),
51 - switch for cabin and compartment lighting
The Commission shall be assisted by a committee responsible for load management,
52 - heater fan switch,
53 - key switch for external lights (positional, passing, road),
54 - fog light key switch,
55 - a key switch for a privileged sound signal,
56 - flash on/off switch,
57 - push-button switch for hazard warning signal,
58 - fog lamp relay,
59 - windscreen washer pump,
60 - rear fog lamp tell-tale (located in the switch of item 54),
61 - Battery ground cable,
62 - rechargeable battery (12 V, 45 A-h) 2 pcs,
63 - starter cable - battery disconnect device,
64 - bipolar battery disconnect device,
65 - resistor,
66, 68, 69 - plug connectors,
67 - ignition and starter switch (with steering wheel lock),
70 - passing beam relay (T-5170),
71 - load compartment lights,
72 - 24 V control lamp (yellow),
73 - auto-pump clutch relay,
74 - auto-pump clutch switch,
75 - push-button switch on the water shut-off valve,
76 - push-button switch,
77 - motor pump clutch brush,
78 - change-over switch for dipped-beam and main-beam headlamps,
79 - Switch for windscreen wiper and sound signal,
80 - Direction indicator switch,
81 - brake light contactor "stop",
82 - rear direction-indicator lamps and hazard warning signal lamps (21 W),
83 - rear lights and brake lights (21 W/5 W),
84 - plug connectors,
85 - reversing lamp lamp (21 W),
86 - registration plate lamp,
87 - rear fog lamp (red 21 W),
88 - voltage switch 12/24 V,
89 - fuel level sensor.

1 - obrotomierz MS-2 autopompy,
2 - lampy kierunkowskazów przednich,
3 - reflektory,
4 - reflektory przeciwmgłowe halogeny (55 W),
5 - sygnał niskotonowy,
6 - sygnał wysokotonowy,
7 - sygnał dźwiękowy (12 V, 50 W),
8 - lampka kierunkowskazu bocznego,
9 - złącze wtykowe,
10 - lampy błyskowe,
11 - świeca zapłonowa 4F75),
12 - czujnik ciśnienia oleju w silniku,
13 - przewód wysokiego napięcia cewka-rozdzielacz,
14 - kondensator przeciwzakłóceniowy odbioru radiowego,
15 - kondensator 022 ME BN-76/3682-04,
16 - cewka zapłonowa (12 V i 15 kV),
17 - alternator 124F2 (14 V x 44 A=616 W),
18 - elektrozawór,
19 - silnik wentylatorów nagrzewnic (8 W),
20 - przewód masowy silnika,
21 – przewód zapłonowy,
22 - aparat zapłonowy (44-44).
23 - czujnik temperatury silnika,
24 - rozrusznik R5c 1,5 kW,
25 - regulator napięcia Re2/12D,
26 - regulator intensywności oświetlenia tablicy wskaźników,
27 - skrzynka bezpieczników dodatkowa,
28 - przerywacz świateł kierunku jazdy,
29 – skrzynka bezpieczników,
30 - silniczek wycieraczki szyby,
31 - włącznik przyciskowy lampy świateł cofania,
32 - sygnalizator uszkodzenia hamulca roboczego (hydraulicznego),
33 - przerywacz świateł awaryjnych,
34 - lampka kontrolna (czerwona) uszkodzenia hamulca roboczego lub włączenia hamulca awaryjnego (postojowego),
35 - lampka kontrolna świateł pozycyjnych (zielona),
36 - gniazdo wtykowe lampy przenośnej,
37 - lampki oświetlenia szybkościomierza,
38 - przekaźnik świateł drogowych,
39 - przekaźnik sygnałów dźwiękowych (PS-1),
40 - lampki kontrolne lamp błyskowych (żółte),
41 - wskaźnik ciśnienia oleju w silniku,
42 - lampki oświetlenia wskaźników,
43 - wskaźnik temperatury silnika,
44 - wskaźnik poziomu paliwa,
45 - wskaźnik prądu ładowania,
46 - lampka kontrolna świateł drogowych (niebieska),
47 - prędkościomierz z licznikiem kilometrowym,
48 - lampka kontrolna kierunkowskazów (zielona),
49 - włącznik przyciskowy lampki kontrolnej włączonego hamulca awaryjnego (postojowego),
50 - lampka oświetlenia kabiny (10 W),
51 - wyłącznik oświetlenia kabiny i przedziału ładunkowego,
52 - włącznik wentylatorów nagrzewnic,
53 - włącznik klawiszowy świateł zewnętrznych (pozycyjne, mijania, drogowe),
54 – przełącznik klawiszowy świateł przeciwmgłowych,
55 – wyłącznik klawiszowy sygnału dźwiękowego uprzywilejowanego,
56 - wyłącznik lamp błyskowych,
57 - przełącznik klawiszowy świateł awaryjnych,
58 – przekaźnik reflektorów przeciwmgłowych,
59 – pomka spryskiwacza szyby,
60 - lampka kontrolna świateł przeciwmgłowych tylnych (umieszczona w przełączniku poz. 54),
61 – przewód masowy akumulatora,
62 - akumulator (12 V, 45 A·h) 2 szt.,
63 – przewód rozrusznika-odłącznik akumulatora,
64 - dwubiegunowy odłącznik akumulatora,
65 - rezystor,
66, 68, 69 - złącza wtykowe,
67 – wyłącznik zapłonu i rozrusznika (z blokadą koła kierownicy),
70 - przekaźnik świateł mijania (T-5170),
71 - lampy oświetlenia przedziału ładunkowego,
72 - lampka kontrolna napięcia 24 V (żółta),
73 - przekaźnik sprzęgła autopompy,
74 – włącznik sprzęgła autopompy,
75 - wyłącznik przyciskowy zaworu odcinającego dopływ wody,
76 – wyłącznik przyciskowy,
77 - szczotka sprzęgła autopompy,
78 - przełącznik świateł mijania i drogowych,
79 – przełącznik wycieraczki szyby i sygnału dźwiękowego,
80 - przełącznik kierunkowskazów,
81 – stycznik światła hamowania "stop",
82 - lampy kierunkowskazów tylnych i świateł awaryjnych (21 W),
83 - lampy pozycyjne tylne i światła hamowania (21 W/5 W),
84 – złącza wtykowe,
85 - lampa światła cofania (21 W),
86 - lampa oświetlenia tablicy rejestracyjnej,
87 - lampa tylna przeciwmgłowa (czerwona 21 W),
88 - przełącznik napięcia 12/24 V,
89 – czujnik poziomu paliwa.



7.3a. Figure: DIAGRAM OF ELECTRICAL INSTALLATION OF A ZUK CAR WITH A 4C90 (DICHOTOMIC) ENGINE

1 - fan electromagnetic coupling, 2 - coupling relay, 3 - fuse 8 A. 4 - oil pressure sensor, 5 - engine temperature sensor, 6 - engine temperature indicator. 7 - oil pressure gauge, 8 - fuse 16 A. 9 - ignition switch, 10 - starter (R11c), 11 - battery disconnector, 12 - 12V batteries. 45 Ah, 13 button on glow plugs, 14 button on glow plugs (137 MJ Beru). 15 - ammeter, 16 - glow plug relay (T-5170). 17 - voltage regulator, 18 - alternator (A124F), 19 - fan heat switch (FTWS), 20 - cable: battery disconnector - starter, 21 - cable: motor battery - weight

1 - sprzęgło elektromagnetyczne wentylatora, 2 - przekaźnik sprzęgła, 3 - bezpiecznik 8 A. 4 - czujnik ciśnienia oleju, 5 - czujnik temperatury silnika, 6 - wskaźnik temperatury silnika. 7 - wskaźnik ciśnienia oleju, 8 - bezpiecznik 16 A. 9 - wyłącznik zapłonu, 10 - rozrusznik (R11c), 11 - odłącznik akumulatorów, 12 - akumulatory 12V. 45 Ah, 13 - wlącznik klawiszowy świec żarowych, 14 - świece żarowe (137 MJ Beru). 15 - amperomierz, 16 - przekaźnik świec żarowych (T-5170). 17 - regulator napięcia, 18 - alternator (A124F), 19 - wylącznik cieplny wentylatora (FTWS), 20 - przewód: odłącznik akumulatorów-rozrusznik, 21 - przewód: akumulator-masa silnika

The power supply system uses a battery with a nominal capacity of 60 Ah or two batteries with a capacity of 45 Ah each (for diesel cars and fire-fighting vehicles) and an alternator with a voltage regulator. The negative terminal(s) of the battery shall be connected to the ground of the vehicle.

The engine and body mounted on the car frame on rubber cushions are connected to each other by a special conductive cable (braided copper wire tape) that conducts the electrical energy well.

Electrical cables and current consumers have plug connectors (connectors), which ensure good and quick connection.

The electrical system of the vehicle consists of the following circuits:

- power supply circuit,
- starting circuit,
- ignition circuit,
- the vehicle lighting circuit,

- the circuitry of the auxiliary electrical equipment.

Electrical circuits, e.g. front and rear right hand lamps for position lamps, front and rear left hand lamps for direction-indicator lamps, etc. (Table 7-24) are protected with thirteen fuses located along the longitudinal axis of the car.

7.1 POWER SUPPLY CIRCUIT

The supply circuit (Fig. 7.1) consists of an alternator (7), a battery (20), a voltage regulator (9), an ignition switch (56) and the electrical conductors connecting these units. Charging the battery in the car is indicated by a test ammeter (38), located on the indicator board, connected to the alternator's “30” terminal by an ignition switch.

7.1.1 Alternator A124F

The alternator is a three-phase alternating current generator with built-in rectification. It consists of a fixed stator, i.e. a armature (11, Fig. 7.4), a rotor (9), a bridge circuit with nine silicon diodes, rectifying a three-phase current, and bearing discs (10, 12) made of aluminium alloy.

When the excitation current flows through the rotor winding, a magnetic field is created which rotates with the poles inside the stator. The magnetic flux flowing through the stator generates a three-phase alternating voltage in the stator windings, thus generating a current that is immediately rectified by the rectifier system. The rectifier consists of nine silicon diodes mounted in a rear bearing shield (12) and a heat sink (15).

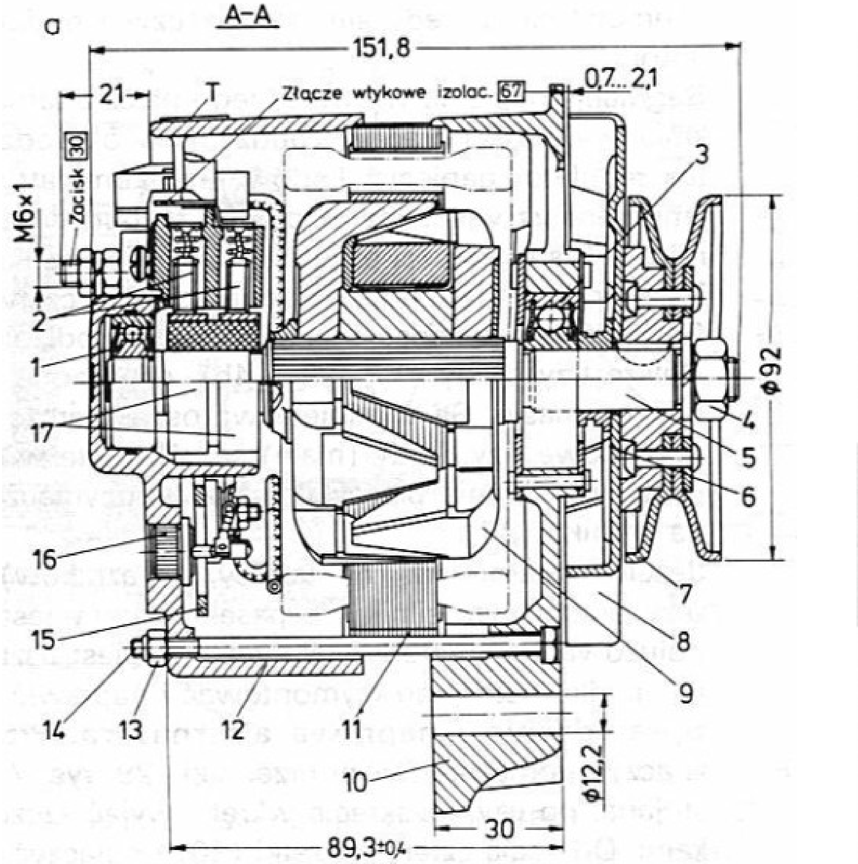
Type of alternator	A124F *
Rated voltage	12 V
Operating voltage	14 V
Battery current (at 14 V)	44 A
Torque	45...71 N·m
Working power	616 W
Rectifier diodes:	
- power diode	25 A
- excitation diodes	1 A
Initial charging speed of the battery	950...1050 rpm
Activation resistance of the windings	4,3 ± 0,2 Ω
Weight	4,2 kg
Durability of the alternator	100 000 km
Order number (with pulley)	024272
Manufacturer	ZEM Świdnica
Requirements and tests according to the standard	BN-81/3681-08

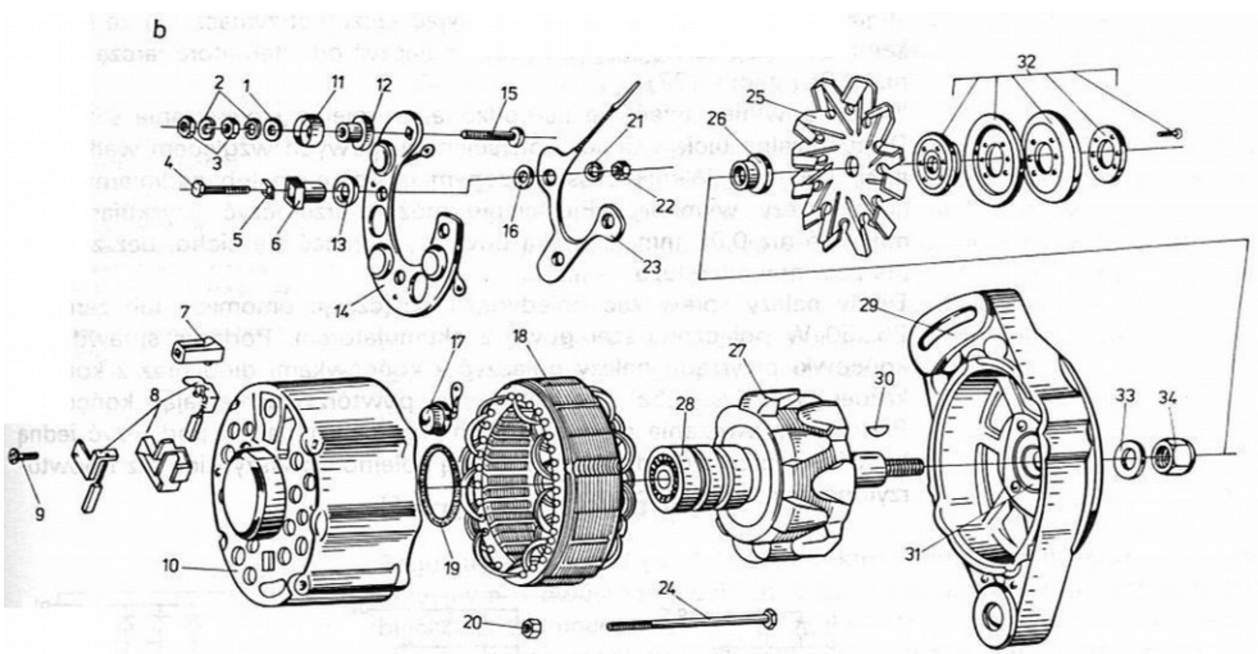
* When used with S-21, 4C90, and PN1600 motors, the alternators for these motors have different mounting bodies and brackets.

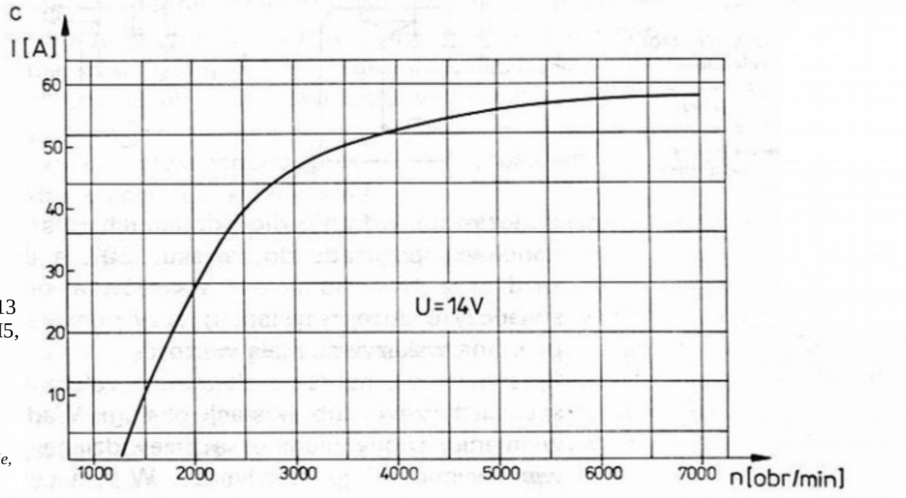
7.1. Table: THE TECHNICAL DATA OF THE ALTERNATOR (DANE TECHNICZNE ALTERNATORA)

From the charger, the current flows to the consumers via the positive terminal of the alternator "30". The DC current to supply the rotor is initially drawn from the battery, and when the generator starts to supply electricity, it is drawn directly from the generator.

7.1.1 Alternator A124F







a - section 1 - rear seal 6201 A. 2 - handle with brushes, 3 - front bearing 6302A 4 - nut M12x1,25,5 - rotor shaft, 6 - bearing seal, 7 - belt pulley, 8 - fan, 9 - rotor, 10 - front disc, 11 - fixed stator, 12 - rear disc, 13 - nut M6, 14 - long screw, 15 - heat sink with negative diodes, 16 - positive diodes, 17 - slide ring

b - Components 1 - Steel washer Ø 6.2 - Spring washer 26.1. 3 - Nut M6, 4 - Screw M4x 28. 5 - Screw plate. 6 - insulation of M4,7 screw - insulation joint, 8 - brush driver, 9 - screw M4x14 with spring washer. 10 - rear disc, 11 - terminal insulation, 30". 12 - insulation (terminal). 13 - insulation washer, 14 - heat sink with diodes, 15 - screw M6x36, 16 - washer Ø 8.2. 17 - diode 25 A, 18 - stator, 19 - rubber ring. 20 - nut M5, 21 - spring washer 24,1, 22 - nut M4, 23 - additional plate, 24 - bolt M5x95. 25 - fan, 26 - spacer sleeve, 27 - rotor, 28 - bearing 6201A, 29 - front disc, 30 - slot 3x5, 31 - bearing 6302A, 32 - pulley, 33 - washer Z12.2. 34 - nut M12x1.25 - nut

C - current characteristics of the alternator

a - przekrój 1 - fożysko tylne 6201 A. 2 - trzymadlo ze szczotkami, 3 - łożysko przednie 6302A 4 - nakrętka M12x1,25,5 - walek wirnika, 6 - uszczelniacz łożyska, 7- koło pasowe, 8 - wentylator, 9 - wirnik, 10 - tarcza przednia, 11 - nieruchomy stojan (twornik), 12 - tarcza tylna, 13 - nakrętka M6, 14 - Śruba długa, 15 - radiator z diodami ujemnymi, 16 - diody dodatnie, 17 - pierścień ślizgowy

b - elementy składowe 1 - podkładka stalowa Ø 6.2 - podkladka sprężysta 26,1. 3- nakrętka M6, 4 - śruba M4x 28. 5 - płytka pod śrubę. 6 - izolacja śruby M4,7 - złącze izolacyjne, 8 - szczotkotrzymacz, 9 - wkręt M4x14 z podkładką sprężystą. 10 - tarcza tylna, 11 - izolacja zacisku „30". 12 - izolacja (zacisk). 13 - podkładka izolacyjna, 14 - radiator z diodami, 15 - śruba M6x36, 16 - podkładka Ø 8.2. 17 - dioda 25 A, 18 - stojan, 19 - pierścień gumowy. 20 - nakrętka M5, 21 - podkładka sprężysta 24,1, 22 - nakrętka M4, 23 - płytka dodatkowa, 24 - śruba M5x95. 25 - wentylator, 26 - tuleja dystansowa, 27 - wirnik, 28 - łożysko 6201A, 29 - tarcza przednia, 30 - wpust 3x5, 31 - łożysko 6302A, 32 - koło pasowe, 33 - podkładka sprężysta Z12.2. 34 - nakretka M12x1.25

C - charakterystyka prądowa alternatora

7.4. Figure: ALTERNATOR A124F

7.1.1 Alternator A124F

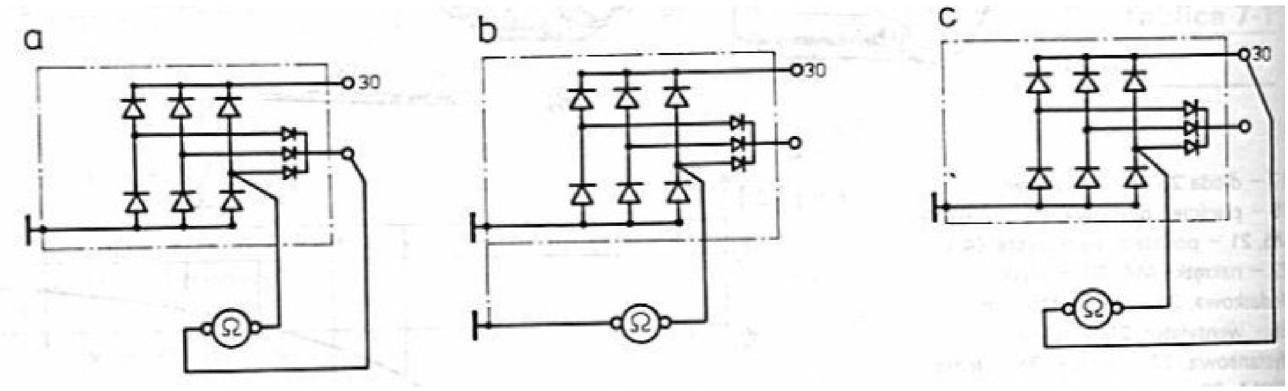
The regulation of the voltage generated by the generator is achieved by changing the excitation current in the rotor circuit. This task is fulfilled by the voltage regulator. Charging of the battery is indicated by an ammeter connected to the excitation circuit. The alternator has a very wide speed range compared to DC generators. Three positive LEDs, marked red, have a plus on the ground. They are pressed into a special plate (14) isolated from the front disc. Another three LEDs (17, Fig. 7.4b), marked in black, have a minus on the mass. They are pressed directly into the front disc (10, fig. 7.4a) and an additional three diodes (small) are pressed into the plate (23). The current for the excitation winding is transmitted by the brush holders (8) and the slip rings on the rotor (27).

If the ammeter (on the dashboard) indicates no charging while the engine is running and the V-belt is properly tensioned and the electrical wiring is not loose, the alternator is defective. In this case, it must be removed and repaired.

Inspection and repair of the alternator. Before removing the stator, mark the positions of the front (29, Fig. 7.4b) and rear (10) discs in relation to the stator, then unscrew the screw and remove the brush holder (8) with the brushes. Unscrew the four nuts (20) and disconnect the front disc (10) and rotor (27) from the alternator.

The rotor shall have undamaged winding and slip rings. It is permissible for the rotor and the slip rings to run 0,05 mm against the shaft. The rotor must be replaced if the winding is damaged or the runout is excessive. The rings can be rolled to a beat size of less than 0,05 mm. Bearings should rotate quietly, without jams and should not be loose.

The LEDs shall be checked individually by connecting an ohmmeter or an incandescent lamp 25...50 W in series with a battery. When checking the tip of the instrument, connect it to the LED terminals and to the end of each phase (Fig. 7.5a). Repeat the measurement by changing the tips. When checking the negative diodes (Fig. 7.5b), connect one end of the instrument to the ground and the other to all phases and repeat the measurement by changing the ends.



7.5. Figure: CHECKING THE ALTERNATOR DIODES

a - wiring diagram of the connections when checking the excitation diodes,
b - wiring diagram of the connections when checking the negative diodes,
c - wiring diagram of connections when checking positive diodes

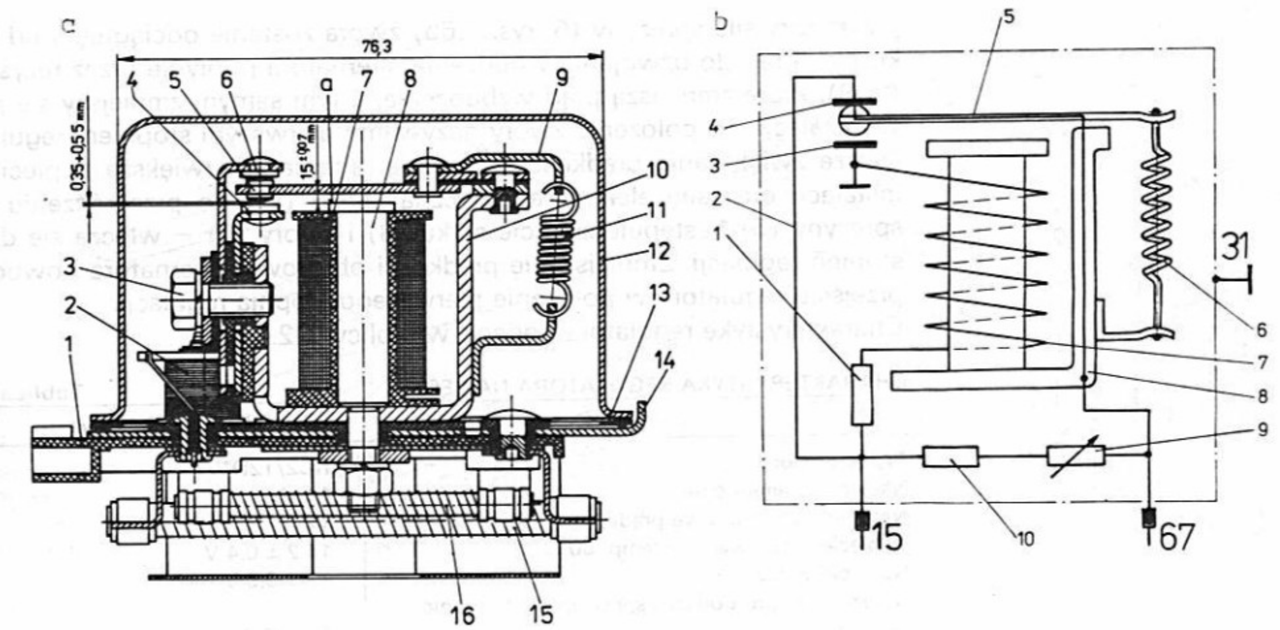
a - schemat elektryczny połączeń podczas sprawdzania diod wzbudzania,
b - schemat elektryczny połączeń podczas sprawdzania diod ujemnych,
c - schemat elektryczny połączeń podczas sprawdzania diod dodatnich

When checking the positive LEDs (Fig. 7.5c), connect one end of the device to the "30" terminal and the other to the phase ends. At each of these measurements the pointer should be stationary

(which indicates a high resistance), at the same time at the opposite measurement the pointer should indicate a small value.

We recommend that you have the alternator checked and repaired by a professional bike workshop or by a service station. Replace defective or worn parts. Negative LEDs are designed as spare parts and can therefore be replaced individually. To do this, press out the LED, drill a 13,12...13,6 mm hole and press in the new LED using a 13,2 x 16,3 mm Ø sleeve. If the positive LED on the heat sink or the excitation diode is damaged, the heat sink must be replaced as it is not supplied with spare parts. The voltage drop in the conductive direction of the diode must also be welded and should be 1.2 V at a flow rate of 25 A at 6 V. To prevent the LED from overheating, the test time should be 5...10 s. At 150 V DC, the conductive current in the stop direction must not exceed 2 mA. When installing the alternator, tighten the screw nuts (14, Fig. 7.4a) that secure the covers to 4 N·m and the pulley nut to 60 N·m. After installation, the alternator shall be checked again on the test bench (it shall have the characteristics specified in the diagram (Fig. 7.4C)).

7.1.2 Voltage regulator



7.6. Figure: VOLTAGE REGULATOR RC2/12D (REGULATOR NAPIĘCIA RC2/12D)

a - construction 1 - plug connector, 2 - coil, 3 - screw, 4 - bottom contact (fixed), 5 - movable jumper, 6 - top contact, 7 - electromagnet, 8 - coil core, 9 - spring holder. 10 - bracket, 11 - spring, 12 - cover, 13 - cover gasket, 14 - base, 15, 16 - resistors b - electrical diagram 1 - compensation resistor. 2-wire, 3-pole lower support contact, 4-pole upper support contact, 5-pole jumper, 6-spring, 7-coil. 8-pole, 9-regulating resistor (double). 10 - chokes. "15" "31" "67" - plug connectors.

a - budowa 1 - złącze wtykowe, 2 - cewka, 3 - sruba, 4 - styk dolny (stały) 5 - zwora ruchoma, 6 - styk górny, 7 - elektromagnes, 8 - rdzeń cewki, 9- uchwyt sprężyny. 10 - wspornik, 11 - sprężyna, 12 - pokrywa, 13 - uszczelka pokrywy, 14 - podstawa, 15, 16 - oporniki b - schemat elektryczny 1 - rezystor kompensacyjny. 2- przewód, 3 - styk wspornika dolnego, 4 - styk wspornika górnego, 5 - zwora, 6 - sprężyna, 7 - cewka. 8-jarzmo, 9 - rezystor regulacyjny (podwójny). 10 - dlawiki. "15" "31" "67" – złącza wtykowe.

The voltage regulator (Fig. 7.6) is a two-stage electromagnetic vibrating regulator. An electromagnet (7) and a U-shaped clamp (made of ferromagnetic steel) are attached to the base (14) of the extruded sheet metal. On one side the T AS of the bucket (5) is attached, which is pulled out by a spring (11). At the end of the pressure switch there shall be movable contacts (top and bottom) between fixed contacts (4, 6) fixed to suitably curved plates.

7.1.2 Voltage regulator

The task of the voltage regulator is to maintain a constant voltage value of the current generated by the generator rectifier system consisting of nine silicon diodes.

The voltage regulator is located in a metal cover with a rubber gasket. It is suitable for use with "15" and "67" plug connectors at the bottom.

At low generator speeds, contact (4) is short-circuited to the jumper (5) and then a current of the same voltage flows through the controller as in the entire electrical system. This current supplies the generator excitation windings. An increase in the rotational speed of the generator causes the excitation of increasingly higher voltage, thus the current flowing through the electromagnet increases the electromagnetic force acting on the jumper (5). If this force exceeds the spring force (6, Fig. 7.6b), the jumper will be pulled away from the contact (4). The current to the generator winding will flow through the resistors (1, 9), which will reduce the excitation current and thus reduce the current in the installation. This position of the jumper is called the first stage of adjustment. Further increasing the rotational speed of the alternator increases the voltage in the system and the electromagnetic force of the coil (8). If the spring force (6) is exceeded, the contact (3) is shorted and the pressure (5) is shorted - the second stage of adjustment is switched on. If the generator speed is reduced, the controller switches to the first regulation stage.

The characteristics of the regulator are given in Table 7-2.

Type of regulator	RC2/12D *
Rated voltage	14 V
Rated current intensity	44 A
Voltage regulated at 50°C	14,2 ± 0,4 V
Switch-on voltage	13 ± 0,5 V
Current intensity during level I regulation level	23...35 A
Current intensity during level II regulation level	2...12 A
Resistance between terminals "15" and "67"	5,65 ± 0,4
Resistance between terminal "15" and ground	27,7 ± 2
Jumper - core gap	1,5 ± 0,07 mm
Gap between bottom contact and jumper (II regulation level)	0,35...0,55 mm
Dimensions	48,3 x 76,0 mm
Weight	0,4 kg
Order number	4296.100

* Applied to S-21, 4C90 and PN1600 engines

7.2. Table: CHARACTERISTICS OF THE VOLTAGE REGULATOR

Do not replace the plug connectors "15" and "67" of the controller or connect the capacitor to the terminal "67".

7.1.3 Accumulators

In cars Zuk with petrol engine S-21 there is used a dry-charged starter battery with nominal voltage 12 V and capacity 60 A·h (Fig. 7.7) and in cars with diesel engine.

4C90 and extinguishing systems two 12V batteries with capacity of 45 A·h connected in parallel (Fig. 7.8). The battery is located under the passenger seat in the driver's cab.

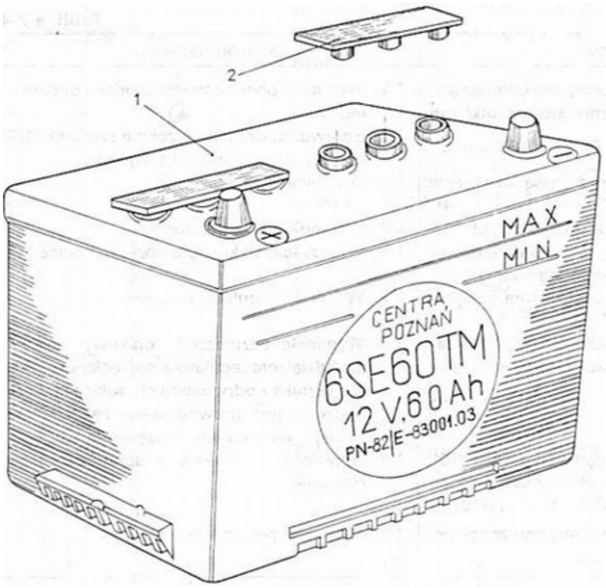
7.1.3 Accumulators

It consists of a housing made of plastic (polypropylene), lead plates and an electrolyte, i.e. an aqueous solution of sulphuric acid H_2SO_4.

Each battery cell has a set of positive and negative plates. Plates of one character are connected to each other. Both sets of plates are placed in a housing that is covered by a cover welded tightly to the housing so that the battery is insoluble.

Characteristics of the batteries are given in Table 7-3.

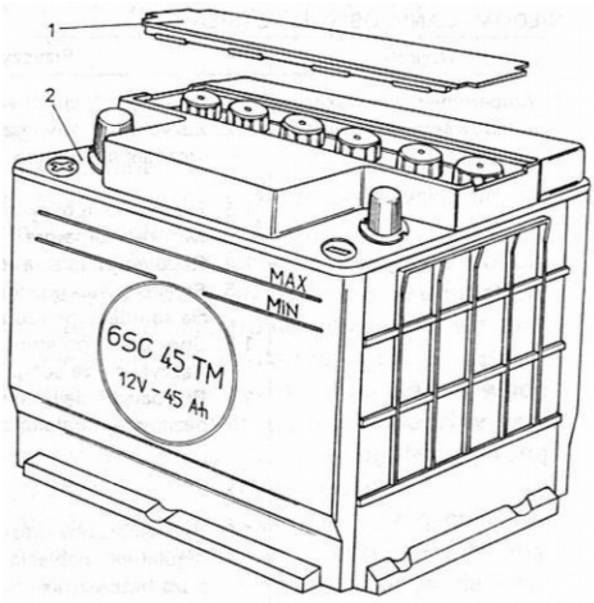
Charging the battery. Batteries lose capacity over time and require additional charging with direct current (Table 7-7). Check the electrolyte level in the battery every two weeks in summer and at least once a month in winter.



7.7. Figure: STARTER BATTERY FOR PETROL ENGINE S-21

1 - battery, 2 – lid

1 - akumulator, 2 - pokrywka



7.8. Figure: STARTER BATTERY FOR AC90 DIESEL ENGINE

2 - battery, 1 – lid

2 - akumulator, 1 - pokrywka

If the electrolyte level drops, only distilled water should be added to the battery. A discharged battery should be recharged as soon as possible and recharged every 4...6 weeks when the vehicle is stationary for a long time. Keep the battery clean and lubricate the poles with technical petroleum jelly or other grease.

Batteries of 60 A·h shall be charged with a maximum DC current of 6 A. Connect the positive terminal (+) of the battery to the positive terminal of the charger, the negative terminal (-) to the negative terminal, and connect the charger to a power source (220 V mains). The battery shall be considered to be charged if the cell voltage and the electrolyte density have stopped increasing within the last two hours of charging and if there is an intensive gassing (intensive gassing does not apply to the first charge, which takes much longer). At the end of the charge, the approximate voltage of the individual cells shall be 2,6...2,8 V and the total voltage at the poles of the battery shall be 15,6...16,8 V.

7.1.3 Accumulators

Type	SE60TM	6SC45TM *
Rated voltage	12 V	12 V
Starting current	200 A	185 A
Twenty-hour capacity (Q_{20})	60 A·h	45 A·h
Charging current (1,0-Q_{20})	6,0 A	4,5 A
Weight of the battery without electrolyte	13,5 kg	10,5 kg
Weight of the electrolyte battery	19,0 kg	13,8 kg
Quantity of electrolyte with a density of 1.26 g/cm3	4,0 dm^3	1,6 dm^3
Dimensions		
- length	max. 272 mm	206 ± 1 mm
- width	173_{-2} mm	175_{-2} mm
- height	223_{-4} mm	190_{-4} mm
Requirements and tests according to	PN-77/E-83001.03	

* For use in diesel vehicles 4C90 (2 pcs.)

7.3. Table: BATTERY CHARACTERISTICS

Trouble	Reasons	Method of repair
1. the ammeter does not indicate that the battery is being charged	1.1. short-circuit of one or more positive diodes.	1.1 Replace the plate with the three positive diodes.
	1.2 Wear or suspension of the alternator brush(s).	1.2 Check that the surfaces of the brushes are in contact with the slip rings.
	1.3. alternator rotor windings interrupted or shorted to earth.	1.3 Replace the rotor.
	1.4 voltage regulator maladjusted.	1.4 Adjust the controller.
	1.5. the contacts of the first stage of the voltage regulator are oxidised or contaminated.	1.5 Clean the contacts and check that they are working.
	1.6 The contacts of the second stage of the voltage regulator are connected to each other.	1.6 Replace the voltage regulator.
	1.7 Burning of the 16 A fuse which protects the voltage regulator.	1.7 Replace the fuse, check the function of the voltage regulator, the rotor winding and the relevant connections; the damage is caused by a short circuit in one of the specified parts.
	1.8 Breaking of the circuit between the '15' terminal of the voltage regulator and the ignition (start) switch outside the 8A fuse	1.8 Repair the connection and check that it is functioning properly.
	1.9 Interruption of the connection between the "67" terminal of the voltage generator	1.9 Repair the connection.
2. Fluctuations in the ammeter display at constant engine speed	2.1. short-circuit of one or more positive diodes.	2.1 Replace the plate with the three positive diodes.
	2.2 Wear or suspension of the alternator brush(s).	2.2 Check that the surfaces of the brushes are in contact with the slip rings.
	2.3 Voltage regulator maladjusted.	2.3 Adjust the voltage regulator.
	2.4 The contacts of the first stage of the voltage regulator shall be oxidised or contaminated.	2.4 Clean the contacts and check that they are working.
	2.5. interrupted connection between alternator battery and the "30" alternator terminal.	2.5 Repair the connection.
	2.6 interruption of the connection between terminal 30"/1" of the ignition switch.	2.6 Repair the connection and check that it is functioning properly.
	2.7. wear and tear or oxidation of the ignition switch contacts corresponding to the circuits 30"/1" 1,15".	2.7 Check the ignition switch contacts; replace if worn out; if oxidised, clean them.
	2.8. short-circuit of one or more negative LED(s).	2.8 Check alternator; replace defective diodes.
	2.9. puncture between stator winding and ground.	2.9 Replace the stator.

7.4. Table: POWER SUPPLY CIRCUIT TROUBLESHOOTING

7.1.3 Accumulators

Trouble	Reasons	Method of repair
1. The regulator does not regulate the generator excitation current.	1.1 Interruption of the coil compensating resistor or the solenoid winding.	1.1 Measure the electrical resistance between the "15" connector and the ground; if this resistance is not compatible, replace the adjuster (ASO).
2. adjustable voltage is unstable, rapidly changing	2.1. break in the auxiliary induction coil winding or in the adjusting resistor so that the contacts stick together or the contact material is transferred from one contact to another.	2.1 Measure the electrical resistance between the "15" and "67" open contacts (top and bottom) and hold the jumper in an intermediate position. If the measurement results are not in accordance with the characteristics, the controller (ASO) shall be omitted.
	2.2 Penetration of water, oil or other objects into the regulator causing oxidation of contacts, loss or excess material of contacts or their sticking together.	2.2 Clean the contacts, adjust the slots, Remove foreign objects and replace the regulator's cover gasket and check the entire power supply system and alternator (ASO).

7.5. Table: REGULATOR TROUBLESHOOTING

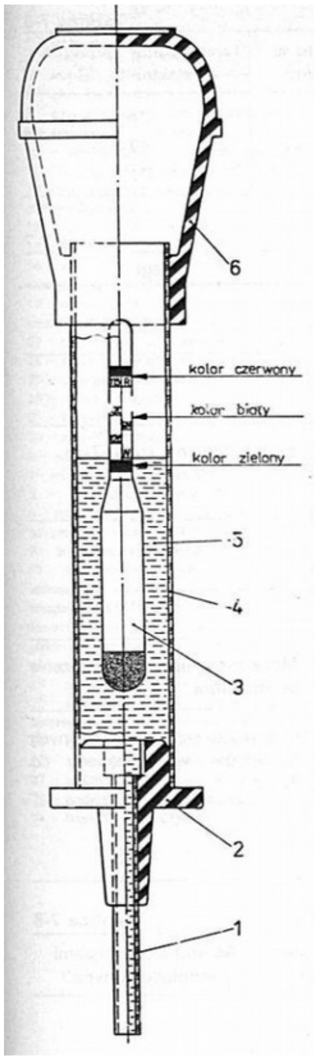
The electrolyte density determining the battery charge state is checked with an areometer (Fig. 7.9). When the temperature of the electrolyte rises to 40° during charging, stop charging for about 30° or halve the charging current.

The old sulphated battery can be charged (recharged) with high current as follows:

- discharge the electrolyte from the battery,
- fill the battery with distilled water,
- charge the battery with a current of 20 A until the electrolyte density is 1,1...1,15 g/cm^3 (battery 60 A·h).

During this charging (high current), lead sulphate gases are emitted very abundantly and fall from the plates to the bottom of the battery. When the electrolyte density reaches 1,1...1,15 g/cm^3 during this charge, the electrolyte is poured out of the battery together with the lead sulphate particles. Pour distilled water back into the battery and charge it again with electricity for up to 4 hours. The maximum permissible gross calorific value shall be 12 A. After this charge, the distilled water is poured out together with the impurities in the form of sludge from the battery plates.

Then fill the battery with 1,28 g/cm^3 electrolyte and charge it with 3 A current until it is properly charged. It should be noted that only a part of deep-sulphurized batteries can be regenerated in the way described.



7.9. Figure: AEROMETR

7.1.3 Accumulators

1 - glass tube, 2 - rubber tip, 3 - float with coloured marks, 4 - glass body, 5 - electrolyte (made of battery), 6 - rubber pears Meaning of colours on the float: red - full discharge of the battery cell, yellow - partial charging of the battery cell, green - correct charging of the battery cell.

1 - rurka szklana, 2 - końcówka gumowa, 3 - pływak ze znakami kolorowymi, 4 - korpus szklany, 5 - elektroit (z akumulatora), 6 - gruszka gumowa Znaczenie kolorów na pływaku: czerwony - całkowite wyładowanie celki akumulatora, żółty - częściowe naladowanie celki akumulatora, zielony - prawidłowe naładowanie celki akumulatora

Positive results of desulphation charging depend to a large extent on skills and practice as well as on the diligence of its execution. It is therefore advisable to have this work carried out by a specialist workshop for recharging the batteries.

■ Prepare the new battery for operation:

- fill the battery with 1.25...1.27 g/cm^3 electrolyte at 20°C to the "MAX" level,
- leave the battery for 4 hours, top up the electrolyte and charge the battery with 3 A for 75 hours until it is fully charged.

Check the electrolyte temperature during charging (must not exceed 40°C) and stop charging if necessary. After charging, thoroughly wash the electrolyte battery with water and wipe dry.

No other repairs shall be made to the battery as both types of battery are indelible.

Please note that sulphuric acid is a corrosive liquid, so wear safety goggles, rubber gloves, apron and boots when working.

Sulphuric acid should be poured into water and never the other way round. If water is poured into concentrated acid, there is a risk of scalding.

Battery status	Electrolyte density at 20°C, g/cm2	Electrolyte freezing temperature, °C
charged (100%)	1,27...1,28	-57
half discharged (50%)	1,18	-24
fully discharged (0%)	1,10	-10

7.6. Table: ZALEZNOSC POJEMNOSCI AKUMULATORA OD GĘSTOSCI I TEMPERATURY ELEKTROLITU

Do not approach an open fire battery during or immediately after charging (after a long drive). This may cause an explosion of gases accumulated in the battery. After working on the battery, wash your hands thoroughly with soap and warm water.

Check the condition and cleanliness of the battery every 2-3 months. Before removing the battery from the vehicle, e.g. for charging, disconnect the cable from the earth terminal (-) and then the positive terminal (+) to prevent accidental short-circuiting. Impacting the terminals to remove them

may damage the battery. The battery pins and cable clamps should be cleaned with a file, a special scraper (cap) or scraped off with a knife and lubricated with technical petroleum jelly.

The dependence of the battery capacity on the density and temperature of the electrolyte is given in Table 7-6 and the requirements in Table 7-7. The battery needs special care during winter as its capacity decreases with the decrease of the ambient temperature.

The battery housing and cable clamps shall be clean, dry and covered with a thin layer of technical petroleum jelly.	
Corner openings and undamaged openings in the cell ventilation plugs	
A discharged battery should be charged as soon as possible and recharged every 4...6 weeks during prolonged periods of inactivity.	Charging current (Table 7-3)
The electrolyte level should be between the "MIN" and "MAX" marks on the battery housing.	
Periodically top up the electrolyte with distilled water.	
Do not discharge or overcharge the battery.	Battery damage may occur.
Do not switch on the starter too often and for more than 5 seconds.	Only 5 successive start-ups are permitted at intervals of 30...6 s
Never short-circuit hoses or make them damp.	

7.7. Table: TECHNICAL CONDITION OF THE BATTERY

Parameter	Battery with non-charged plates	Dry-plate battery *
Battery standstill time after electrolyte flooding prior to connection to power supply (charging)	3...4 h	20 min
Electrolyte level compensation	per point 2	per point 2
Charging time	60...70 h for signs of full charge (according to paragraph 7)	4...15 h
Charging current (A)	0,05 Q_{20} A	0,1 Q_{20} A

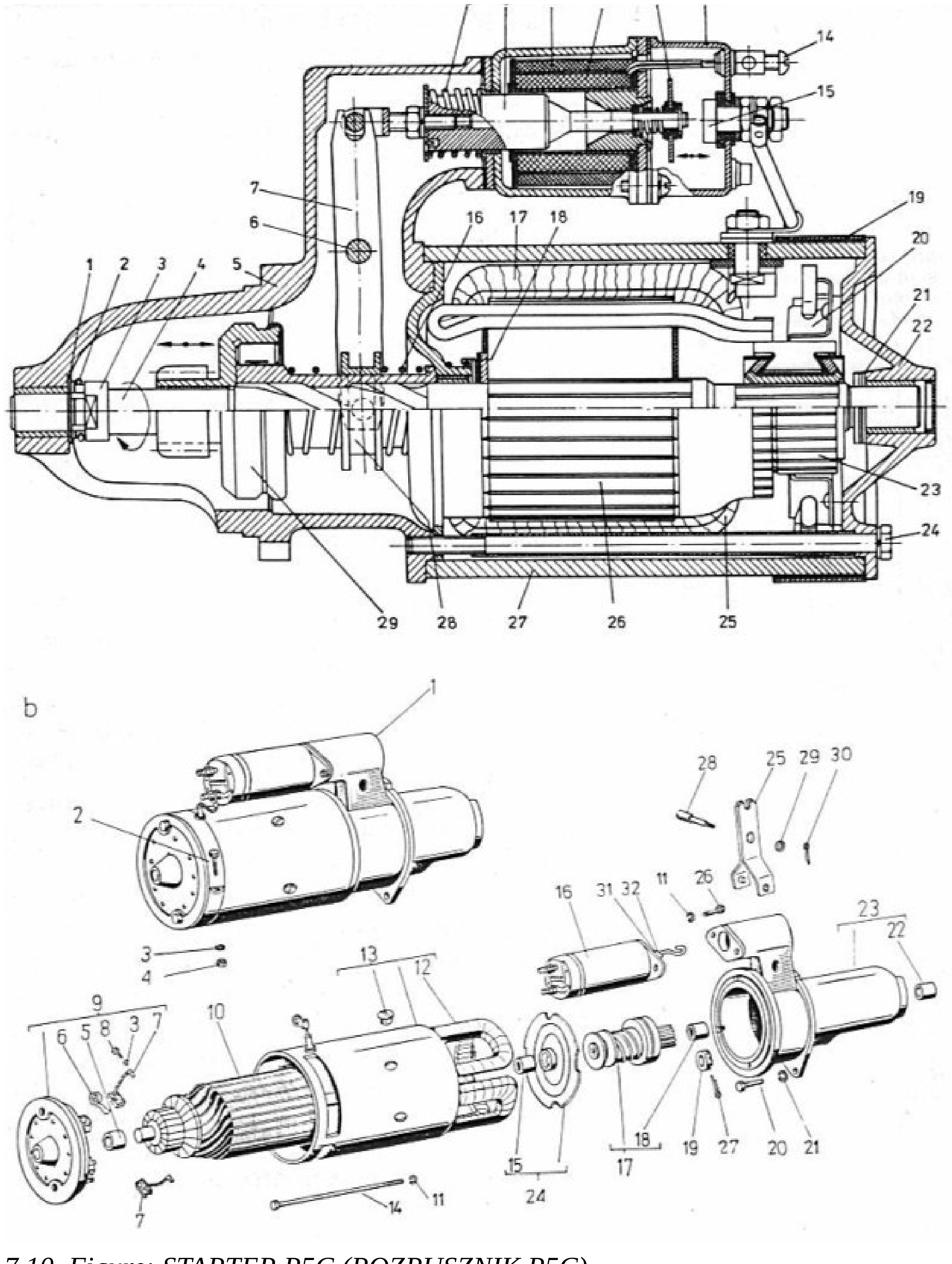
* Dry-charged batteries used in Zuk vehicles are marked:
in words "dry-charged", using the letter "S" or a red circle on the battery housing.

7.8. Table: PARAMETERS OF FIRST BATTERY CHARGE

7.2 START-UP CIRCUIT

The starting circuit consists of an electric starter, an ignition switch and a battery (see Fig. 7.1 - insert).

7.2.1 Electric starter



7.10. Figure: STARTER R5C (ROZRUSZNIK R5C)

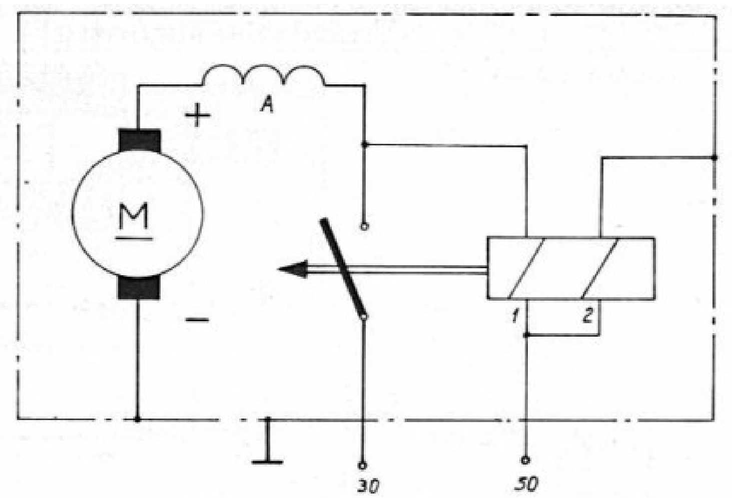
a - section 1 - padding, 2 - pin, 3 - crown nut, 4 - shaft, 5 - body head, 6 - pin. 7 coupling mechanism lever, 8 - spring, 9 - anchor, 10 - switch support winding, 11 - switch support winding, 12 - movable contact, 13 - complete electromagnetic switch. 14 - terminal (M4) of the electric cable. 15 - fixed contact, 16 - springs. 17 - excitation winding, 18 - insulation pad. 19 - protective band, 20 - holding brushes, 21 - spacer washer, 22 - rear disc, 23 - commutator, 24 - tightening screw M6, 25 - rotor winding, 26 - complete rotor. 27 - body, 28 - coupling plate, 29 - coupling unit b - components 1 - starter, 2 - screw M4x20. 3 - spring washer, 4 - nut, 5 - bearing sleeve, 6 - spiral spring, 7 - brush, 8 - screw, 9 - rear bearing shield, 10 - rotor, 11 - spring washer, 12 - excitation coils, 13 - body, 14 - tightening screw M6x161, 15 - bearing sleeve, 16 - WEC5c electromagnetic switch, 17 - coupling assembly, 18 - bearing sleeve, 19 - crown nut M14x0,75, 20 - bolt M12x35, 21 - elastic pad, 22 - bearing sleeve, 23 - head, 24 - intermediate disc, 25 - lever, 26 - bolt M6x16, 27 - pin, 28 - axial pin. 29 - washer, 30 - pin, 31 - pin, 32 - spring

a - przekrój 1 - podkladka, 2 - zawleczka, 3 - nakrętka koronowa, 4 - wałek, 5 - głowica korpusu, 6 - sworzeń. 7-dźwignia mechanizmu sprzęgającego, 8 - sprężyna, 9 - kotwica, 10 - uzwojenie podtrzymujące wyłącznika, 11 - uzwojenie włączające wyłącznika, 12 - styk ruchomy, 13 - wyłącznik elektromagnetyczny kompletny. 14 - zacisk (M4) przewodu elektrycznego. 15 - stały styk, 16 - sprężyny. 17 - uzwojenie wzbudzenia, 18 - podkładka izolacyjna. 19 - opaska ochronna, 20 - trzymadlo szczotek, 21 - podkładka dystansowa, 22 - tarcza tylna, 23 - komutator, 24 - śruba ściągająca M6, 25 - uzwojenie wirnika, 26 - wirnik kompletny. 27 - korpus, 28 - tarczka sprzęgająca, 29 - zespół sprzęgający b - elementy skladowe 1- rozrusznik, 2 - wkręt M4x20. 3 - podkładka sprężysta, 4 - nakrętka, 5 - tuleja łożyskowa, 6 - sprężyna spiralna, 7 - szczotka, 8 - wkręt, 9- tarcza łożyskowa tylna, 10 - wirnik, 11 - podkładka sprężysta, 12 - cewki wzbudzenia, 13 - korpus, 14 - śruba ściągająca M6x161, 15 - tulejka łożyskowa, 16 - wyłącznik elektromagnetyczny WE5c, 17 - zespół sprzęgający, 18 - tuleja łożyskowa, 19 - nakrętka koronowa M14x0,75, 20 - śruba M12x35, 21 - podkladka sprężysta, 22 - tulejka łożyskowa, 23 - głowica, 24 - tarcza pośrednia, 25 - dźwignia, 26 - śruba M6x16, 27 - zawleczka, 28 - sworzeń osiowy. 29 - podkładka, 30 - zawleczka, 31 - trzpień, 32 - sprężyna

7.2.1 Electric starter

The starter is a direct current electric serial motor with an electromagnetic switch for the gearing of the flywheel rim. Characteristics and types of starters depending on the type of engine used in cars are given in Table 7-9.

■ The starter (Fig. 7.10) consists of a body (27) made of high-magnetic permeability steel, a cast iron head (5), a rotor (26), excitation windings (17), a rear disc (22), a coupling assembly (29), an electromagnetic switch (13) and a coupling mechanism lever (7). An electrical diagram of the starter unit is given in Figure 7.11.



A - serial winding of the starter. 1 - breaker support winding, 2 - breaker draw winding, "30" "50" - electrical cable connectors

A - uzwojenie szeregowe rozrusznika. 1 - uzwojenie podtrzymujące wylacznika, 2 - uzwojenie wciągające wyłącznika, "30" "50" - złącza przewodów elektrycznych

7.11. Figure: ELECTRICAL DIAGRAM OF THE STARTER

There are four windings in the starter (Fig. 7.10):

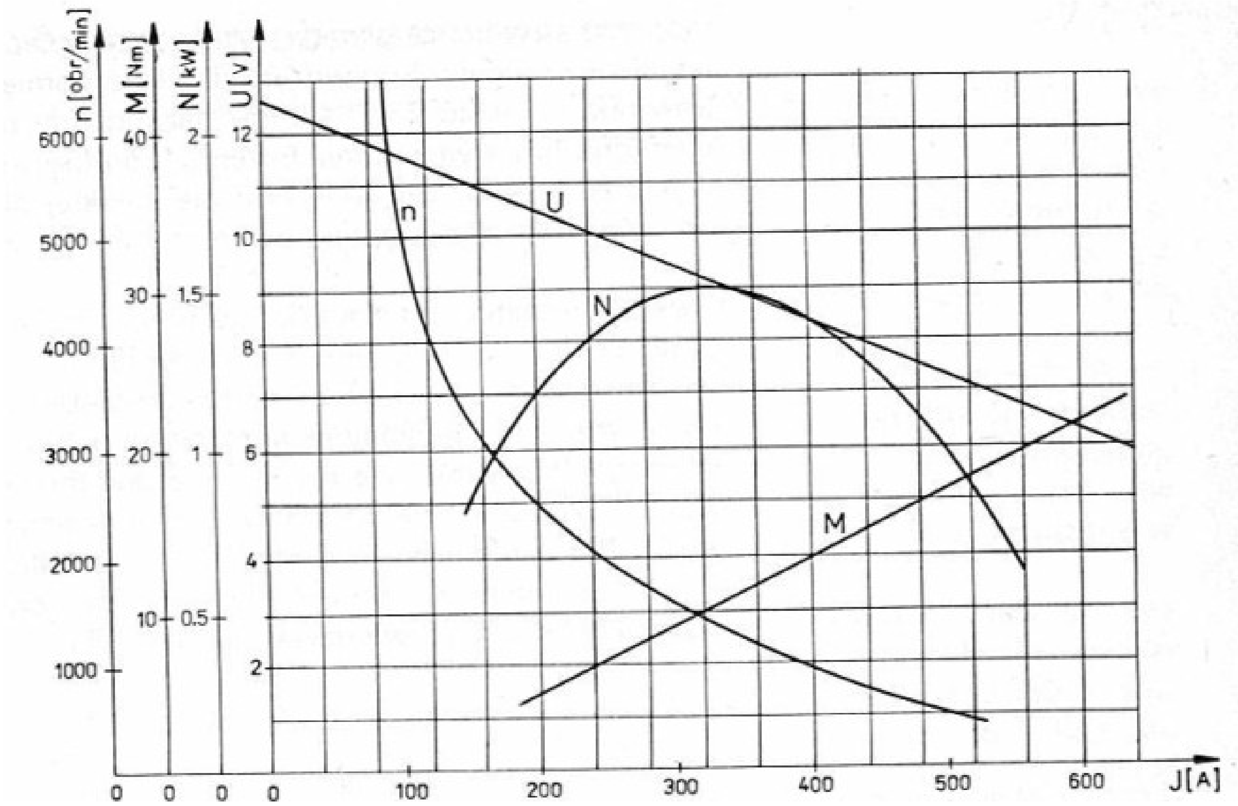
- the winding of the maintenance solenoid switch (10) and the circuit breaker (11),
- excitation winding (17),
- rotor winding (25).

After turning the ignition key to the "start" position, the battery current supplies the switch's switching winding (11). This creates a magnetic field which draws in the anchor (9) with the jumper movement and thus the current from the battery starts to flow directly to the starter. Anchor displacement (9) causes the coupling mechanism lever (7) mounted on the pin (6) to rotate, the coupling plate (28) to move and thus the coupling assembly (29) to move. If the tooth of the coupling unit hits the notch in the flywheel flange, there will be a gearing and when the movable contact (12) shortens the contact (15), the starter will start operating normally. If the tooth of the coupling unit (29) hits the tooth of the flywheel rim and the gear cannot penetrate, the spring (16) is significantly deformed by the disc (28). As soon as the mobile contact (12) shortens the contact (15), the starter rotor and coupling unit (29) rotate and the pinion teeth move to the notches of the flywheel rim, the spring (16) will insert the coupling unit into the flywheel rim. The coupling assembly is mounted on a screwed multicoupler of the rotor shaft. During rotation, axial force shall be produced to prevent the coupling unit from self-cutting. The coupling unit shall have a non-return clutch. When the engine is started and the flywheel rotational speed increases, the one-way clutch will trip to prevent the starter from starting up. When the ignition key is released (it returns to the GO position), the current in the solenoid switch circuit will stop, the spring will pull the core

out of the electromagnet (10, 11), disconnecting the moving contact (12) from the DC contact (15) and the current will stop flowing in the starter circuit. Simultaneously the lever (7) pulls the coupling unit (29) out of the gearing with the flywheel rim. Thanks to the screwed spline on the starter shaft, the pushing force of the coupling assembly acts on the accelerating flywheel. In case of malfunction of the starter, it should be disassembled and the mechanical and electrical operation checked. The starter must not have cracks, deformations or loose connections.

Applied to the engine	S-21	4C90	PN1600/CB
Typ	R5C	R11C	E100N
Rated voltage	12 V	12 W	12V
Rated power	1,5 kW	3 kW	1,5 kW
Battery capacity at rated power	105 A·h	143 A·h	60 A·h
Direction of rotation	right	right	right
Starting torque of full braking at 600A consumption	26 N·m	44,1 N·m	19,6 N·m
Idling speed at I 85 A	-	6000 rpm	-
Power consumption at idle (5000...7000 rpm)	85 A		85 A
Number of pinion teeth	9 pcs	9 pcs	9 pcs
Module	2,5 mm	3 mm	2,5 mm
Angle	15 °	15 °	20 °
Weight	10,1 kg	16 kg	8,7 kg
Order number	82200.2	856.000.0	801.000.0
KTM	101108	-	301102

7.9. Table: STARTER CHARACTERISTICS



7.12. Figure: CHARACTERISTICS OF THE R5C STARTER

n - speed, M - torque, N - power. U - supply voltage

n - prędkość obrotowa, M - moment obrotowy, N - moc. U - napięcie zasilania

7.2.1 Electric starter

The gear wheel of the coupling unit shall not be damaged. The coupling unit shall move gently and without jams along the screwed shaft spline. Turning the gear clockwise (viewed from the starter head) should release the non-return clutch. Rotation in the opposite direction should be carried out together with the rotor. The distance between the tooth ends of the coupling unit and the housing shall be 32,5 ± 1 mm (adjustable by underlays Ø 14,1 x Ø 25 x 0,5 mm on the shaft from the rear disc) and shall be 0,4...2,0 mm. The brush pressure on the commutator should be 6...10 N. Checking the internal parts requires disassembling the starter. If the rotor or head has been replaced, remember to adjust the axial clearance of the armature by inserting the correct number of washers. Check the suitability of the part for further work in the dismounted starter. The insulation strength of the windings is tested with a 500 V alternating current for puncture resistance and with a 120 V alternating current for puncture resistance between switching pieces.

To replace the starter winding, unscrew the pole screws with an inertia screwdriver. The new winding should be heated to 50°C before installation. Thanks to heating, the winding becomes more flexible and adheres better to the poles. When installing the windings, the screws should be screwed on in steps so that the windings are better aligned. Check the distance between the poles, which should be $73{,}7^{+0.3}$ mm. Damaged pole plugs can be replaced or replaced (together with the body) with new ones. The repair can be carried out by placing a thin sheet of steel underneath it, screwing it to the body and then rolling it to the nominal size ($73{,}7^{+0{,}3}$ mm).

If the commutator is renovated or excessively worn, it must be repaired by rolling it. After rolling, the puncture should not exceed 0,04 mm. After rolling, deepen the grooves between the parts of the commutator (to the required depth of 1 mm).

Dimensional requirements of the starter are given in Table 7-9. After mounting the starter, its operation and characteristics should be checked (Fig. 7.12). The operation of the starter is checked without load, with braking and with load. The capacity of the test battery shall be large in order to provide the necessary test voltage.

7.2.1 Electric starter

Trouble	Reasons	Method of repair
1. Starter does not work	1.1 No contact between brushes and commutator.	1.1 Check brushes and pressure springs; replace if worn.
	1.2 Damaged Switch.	1.2 Replace the Switch.
	1.3. short-circuit of the excitation winding or armature with ground.	1.3 Return the starter unit for repair.
	1.4 Damaged solenoid switch	1.4 Replace defective switch.
	1.5. corroded or loosened starter or battery terminals.	1.5 Check and, if necessary, clean the terminals or tighten the wires.
	1.6 Battery fully discharged	1.6 Charge the battery.
	1.7 No contact in the ignition switch.	1.7 Replace defective switch
2. Starting device rotates very slowly the engine flywheel; the lights turn off when the engine is switched on.	2.1 Rechargeable battery strongly discharged.	2.1 Charge the battery.
	2.2. excessively worn brushes.	2.2 Replace brushes.
	2.3. short-circuit in the rotor or excitation windings.	2.3 Find a short circuit and make a repair (ASO).
	2.4 Corroded terminals of the battery and terminals of the wires.	2.4 Clean the clamps and the ends, and cover the cleaned ends with a thin layer of vaseline.
	2.5 Excessive crankshaft resistance.	2.5 Check manual crank handle, cause, troubleshoot.
3. Starter does not rotate the engine flywheel	3.1. coupling device defective.	3.1 Replace defective unit.
	3.2. damaged or excessively worn teeth of the starter pinion.	3.2 Replace the defective pinion (ASO).
4. excessive noise level of the starter during operation	4.1 Excess wear in the rotor bearing sleeves.	4.1 Replace the rotor's self-lubricating bushings.
	4.2. rotor rubbing against rotors.	4.2 Replace the rotor (ASO).
	4.3 Incorrect adjustment of the gear shift and breakage of the switch contacts.	4.3 Adjust the mechanism (Chap. 7.2.2).
	4.4. diagonal attachment of the starter.	4.4 Check and, if necessary, correct the attachment.
5. the starter pinion is to be cut off from the flywheel rim with a delay	.1 The mechanical lever of the gearing is delayed in movement due to damage or deformation of the spring of the electromagnet core, seizing of the core of the electromagnet on the lever pin.	5.1 Replace defective parts or repair them at the ATS.
	5.2. coupling sleeve seized or coupling sleeve return spring defective.	5.2 Replace defective parts in the ATS.

7.10 Table: STARTER DEVICE TROUBLESHOOTING

7.2.2 Repair of the starting circuit

In order to check the condition of brushes, remove the sealing band of the starter body and visually (when lighting with a portable lamp) and by touch check the condition of the surface of the commutator, brushes and hold-brushes (20, Fig. 7.10). Crushed and excessively worn brushes with a height of less than 20 mm and a clamping force of less than 9 N must be replaced.

The new brushes must be carefully reached by the commutator (abrasive paper). The surface of the commutator should be clean. It is necessary to pay attention to the place where the rotor windings are soldered to the plots of the commutator. Soldering should be smooth, fill joints well and do not have any signs of melting. The starter brushes should be seated in the grips without any noticeable slack.

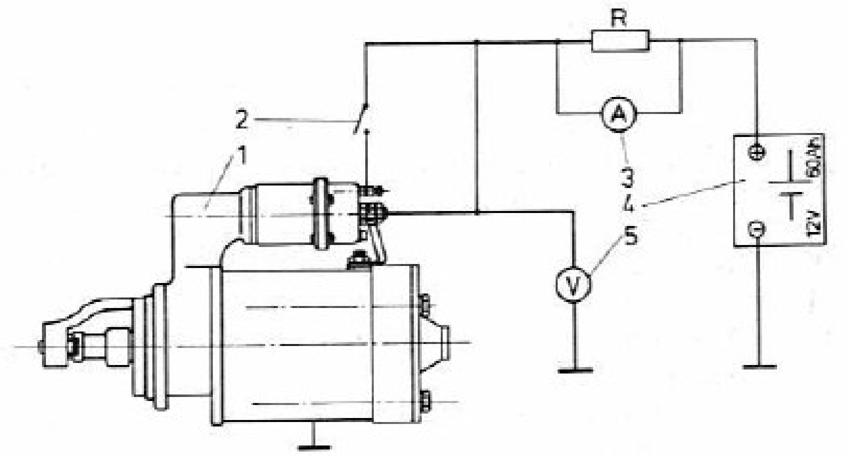
The technical condition of the starter is checked on the test stand without load and under load according to the diagram (Fig. 7.13). Use a DC voltmeter in the range 0...30 V, a bypass ammeter up to 1000 A and a tachometer up to 10 000 rpm to check this. After the power supply is turned on, the starter should operate for 30 seconds. At the end of the test, check the instrument readings. The starter unit must be considered operational if the indicated values are: 11,4...12,6 V, current approx. 85 A, rotation speed approx. 5000 rpm.

7.2.2 Repair of the starting circuit

If the current consumption is greater than 85 A and the voltage and speed is lower than the given values, it means that the rotor winding is damaged or excited, or the mechanical resistance is high. If the current and speed are lower than those required for the correct voltage, it must be assumed that the starter brushes do not have the correct contact with the commutator, or that the wire connections are not correct. Testing of the operation of the starter under load may be carried out only in the repair shop, using a brake with a dynamometer to brake the starter. After positive results of the technical condition tests, a test of the operation of the starter in the car and of the entire start-up circuit should be carried out. Before this test, the driving beam(s) shall be switched on and the brightness of the driving beam(s) shall be ensured. When the starter is switched on, the traffic lights will go out clearly. If, during the test of operation, the starter switches on and off immediately, without any rasps, sounds, etc., and turns the crankshaft at a sufficient speed, the starting system may be regarded as good.

1 - starter, 2 - switch, 3 - ammeter, 4 - battery, 5 - voltmeter

1 - rozrusznik, 2 - wyłącznik, 3 - amperomierz, 4 - akumulator, 5 - woltomierz



7.13 Figure: DIAGRAM OF MEASUREMENT OF TECHNICAL CHARACTERISTICS OF THE STARTER AT IDLING SPEED

During the test, check (by touch) the temperature of the connectors of the supply line to the starter and the temperature of the starter body, brushes and commutator. Too high a temperature of these parts indicates high current flow resistance, which can lead to their damage.

In this case, voltage drops at the electrical connectors of the starting system must be measured to locate and determine the malfunction. If the traffic lights are poorly lit when switched on and the starter switches them off completely or almost completely, this is due to the poor state of the battery. If the traffic lights are on well and switching on the starter causes their almost complete extinction (the starter does not work, but one can hear the starter pin getting into the gear of the flywheel), it should be concluded that there is an incorrect connection between the battery and the starter or between the ground and the battery. If, after switching on the starter, the traffic lights only turn off and the starter does not turn the crankshaft of the engine or rotates it slowly, look for faults in the starter.

The defective solenoid switch (13) of the starter must be unscrewed from the body (5) and replaced with a new one.

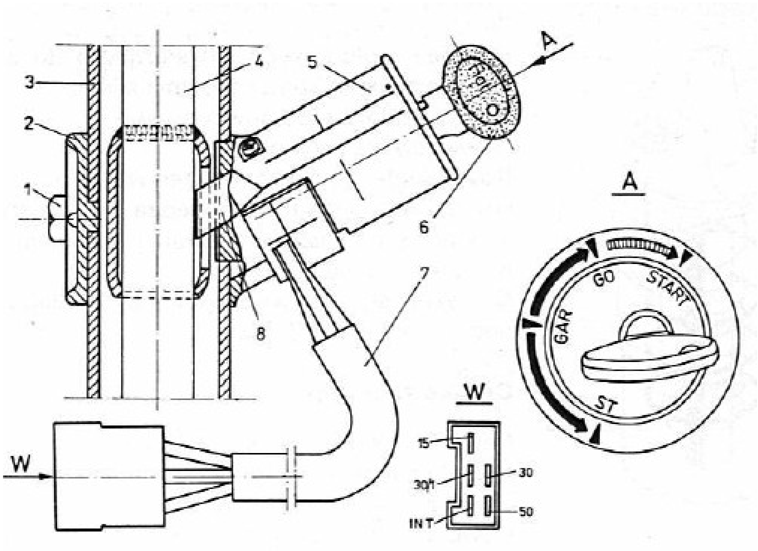
An ignition switch with a steering wheel lock (Fig. 7.14) mounted on the steering column is used in the circuit. The switch consists of a body (5) cast from an aluminium alloy, a control plate (inside

the body) and a cover (2) cast from an aluminium alloy, a wire (7) and a key (6). It is activated by turning the rotating drum with the key latches (6). The cylinder rotates with a cam to control the back and forth movement of the lock on the steering shaft (4) and a spring tensioning clip on the return spring, as well as a cam to control the contact closing.

The ignition switch has four key positions (Table 7-11). To lock the steering, move the vehicle's wheels to the straight-ahead position and turn the key to the left (ST). In this position, the bolt (8) of the switch enters the channel of the steering sleeve (4). The steering wheel is locked only after removing the key from the switch (from the STOP position). In all other positions of the key, the locking bolt (8) does not slide out of the Switch body.

Location of the key	**Circuits switched on**	**No. of live connector**
O (GAR)	All receivers switched off (key removable)	30/ 30/1
1 (GO)	Direction-indicator lamps, exterior lamps, fittings	30- INT
	Ignition, charging circuit, signalling	30/ 1-15
2 (START)	Starter	30-50
	External lights, equipment	30-INT
	Ignition, charging circuit, signalling, equipment	30/1-15
3 (STOP)	Switched off all receivers (after removing the key the steering wheel is locked when the wheels are in the straight-ahead position)	30 30/1

7.11 Table: POSITION OF THE IGNITION KEY IN THE IGNITION SWITCH



1 - special screw, 2 - cover, 3 - steering column, 4 - top steering shaft, 5 - switch body, 6 - key, 7 - electric wires, 8 - lock of steering shaft,

1 - śruba specjalna, 2 - pokrywa, 3- kolumna kierownicy, 4 - wał kierownicy górny, 5 - korpus wyłącznika, 6 - kluczyk, 7 - przewody elektryczne, 8- rygiel blokady wału kierownicy,

7.14 Figure: IGNITION SWITCH (WYŁĄCZNIK ZAPŁONU)

When the GAR key is rotated, the bolt is retracted into the notch of the cylinder housing. The cable with connectors (7) can be replaced with a new one. The contacts in the board can be cleaned. To replace this cord, unscrew the two screws, remove it and insert a new one.

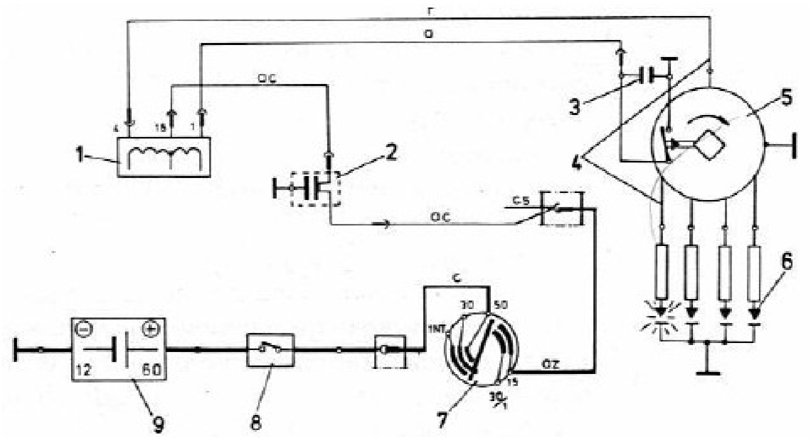
7.3 IGNITION CIRCUITS

As part of the extensive modernization of the Żuk car, in January 1992 an electronic ignition to the S-21 engine was introduced, adapted from the Polonez 1600 car (II version of the ignition).

7.3.1 S-21 engine ignition circuit

The ignition circuit (Fig. 7.15) consists of

- the battery (9) running parallel to the generator via the voltage regulator,
- an ignition coil (1) which converts a low voltage (12 V) into a high voltage (approximately 15 kV) required to produce the spark between the electrodes of the spark plugs,
- an ignition distributor (5) which distributes the high voltage current to the spark plugs,
- spark plugs (6) to produce spark discharges within the engine combustion chambers,
- ignition cables (4),
- an ignition switch (7).

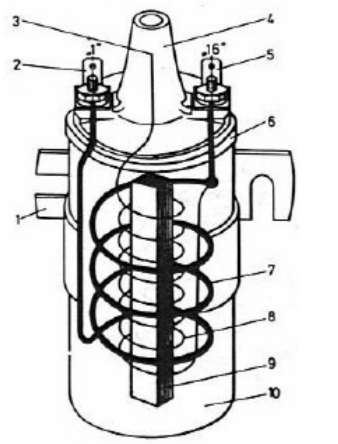


1 - ignition coil, 2 - interference capacitor. - 3 - ignition circuit capacitor, 4 - ignition wires, 5 - ignition distributor, 6 - spark plugs, 7 - ignition switch, 8 - battery disconnector, 9 - battery

1 - cewka zapłonowa, 2 - kondensator przeciwzakłóceniowy. - 3 - kondensator obwodu zaplonu, 4 - przewody zapłonowe, 5- rozdzielacz zapłonu, 6 - świece zapłonowe, 7 - wylacznik zaplonu, 8 - odłącznik akumulatora, 9 - akumulator

7.15 Figure: SCHEMAT OF S-21 ENGINE IGNITION (ordinary)

A capacitor (3) adjacent to the ignition distributor interrupter contacts reduces wear on the interrupter contacts and extends the duration of the spark discharge, resulting in better combustion of the fuel in the engine.



1 - fastening bracket, 2 - 5 - plug connectors "1" and "16". 3 - high-voltage cable socket, 4 - head, 6 - housing, 7 - primary winding, 8 - secondary winding, 9 - coil core, 10 - transformer oil

1 - obejma mocująca, 2. 5 - złącza wtykowe "1" and "16". 3 - gniazdo przewodu wysokiego napięcia, 4 - glowica, 6 - obudowa, 7 - uzwojenie pierwotne, 8 - uzwojenie wtórne, 9 - rdzeń cewki, 10 - olej transformatorowy

7.16 Figure: IGNITION COIL

The characteristics of the ignition circuit of the S-21 ordinary and electronic engine are given in Table 7-12.

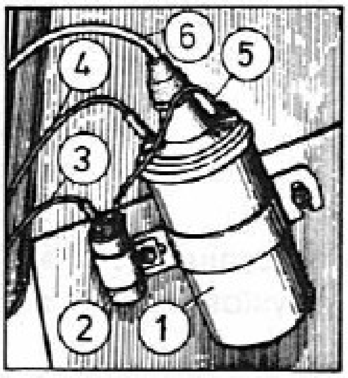
Ignition coil

The ignition coil (Fig. 7.16) consists of a housing (6), pressed from aluminium sheet, in which the core (9) with the primary and secondary winding is placed.

The coils are immersed in transformer oil, which fills the housing by approx. 70% of its volume.

The remaining part of the coil casing is occupied by air, which allows for changes in oil volume caused by heating and cooling of the winding. The end and beginning of the primary winding are connected to the low voltage side connectors, marked with numbers "1" and "16", to which the ignition switch cable (the "1" connector) and the cable from the insulated interrupter connector on the ignition apparatus body are connected.

The secondary winding is connected by one end to the primary winding and by the other end to the centre socket of the coil, from where it is connected by a high voltage cable to the ignition distributor head. The ignition coil (1) with capacitor (2, Fig. 7.17) is mounted vertically on the front baffle with two screws by means of a clamp. The coil is undamageable and must be replaced in the event of wear or damage.



7.17 Figure: INSTALLATION OF AN IGNITION COIL

1 - coil,
2 - interference suppression capacitor for radio reception,
3 - cable: capacitor-cable harness,
4 - Solenoid Power Cable,
5 - capacitor cable,
6 - ignition distributor cable

1 - cewka,
2 - kondensator przeciwzakłóceniowy odbioru radiowego,
3 - przewód: kondensator-wiązka przewodów,
4 - przewód zasilania cewki,
5 - przewód kondensatora,
6 - przewód do rozdzielacza zaplonu

Ignition distributor

The distributor is seated: in the motor hull opening (3) on the left (Fig. 7.18). It is driven by the oil pump shaft (2), which is driven by the camshaft (5).

The ignition distributor has three tasks:

- interrupts the low voltage circuit,
- distributes the high voltage to the motor cylinder plugs,
- accelerates or delays the ignition preview angle depending on the rotational speed and vacuum in the engine suction line.

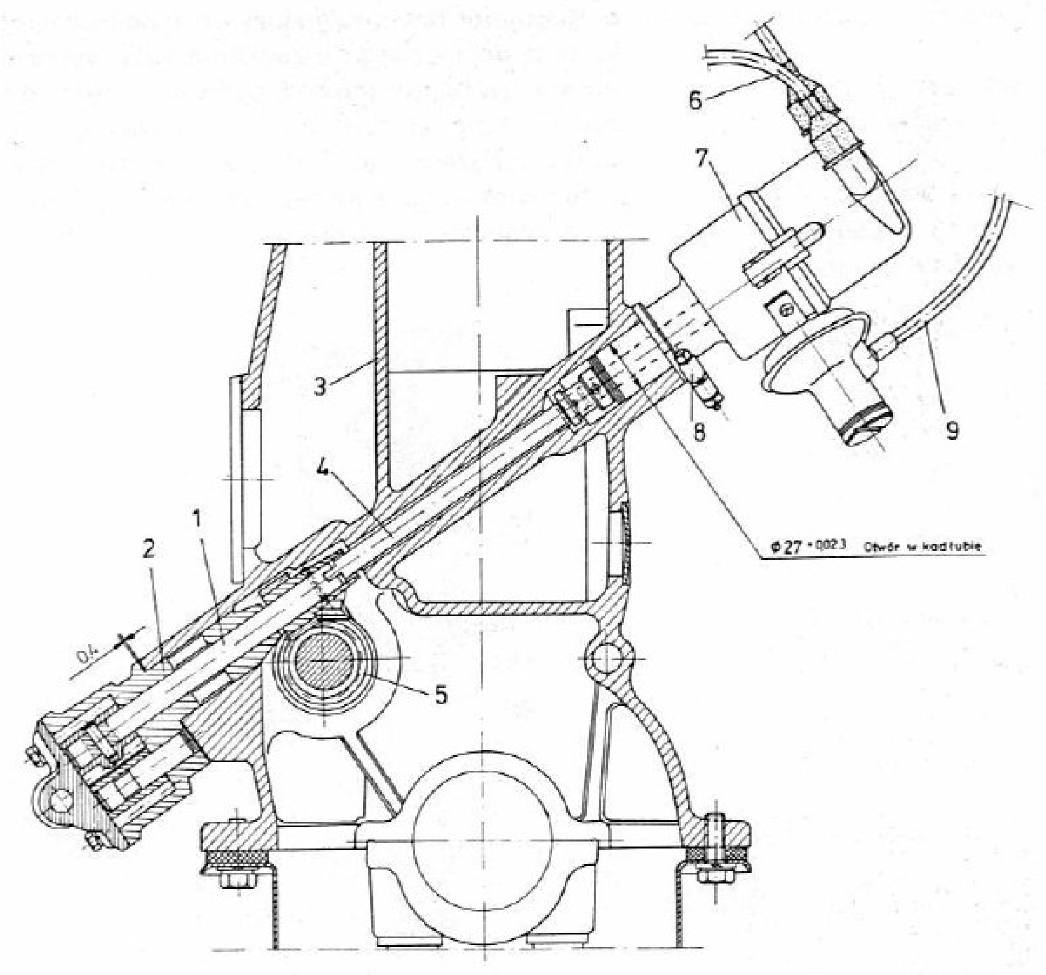
The main parts of the ignition distributor (Fig. 7.19) are:

- body (10) cast in aluminium alloy into which the bearing sleeves (9) are pressed,
- two-part drive shaft (14, 16) with cam bushing (17) and centrifugal control (7),
- vacuum regulator (31),

7.3.1 S-21 engine ignition circuit

- octane regulator (27, 28),
- low-voltage circuit breaker (18), located in the distributor body,
- high voltage distributor (4, 3), located in the head,
- head (1) made of bakelite with embedded brass high voltage (ignition) cable sockets.

■ The ignition distributor is equipped with regulators for automatic regulation of the ignition advance angle; centrifugal as a function of engine rotation and vacuum as a function of vacuum in the engine suction pipe.



1 - oil pump, 2 - oil pump shaft, 3 - engine hull, 4 - ignition distributor drive shaft. 5 - camshaft, 6 - ignition cables, 7 - ignition distributor. 8- distributor mounting plate, 9 - vacuum regulator duct

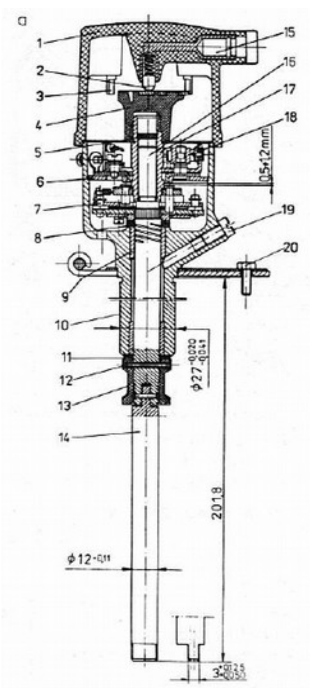
1 - pompa oleju, 2 - walek pompy oleju, 3 - kadłub silnika, 4 - wałek napędu rozdzielacza zapłonu. 5 - walek rozrządu, 6 - przewody zapłonowe, 7 - rozdzielacz zapłonu. 8- płytka mocowania rozdzielacza, 9 - przewód regulatora podciśnieniowego

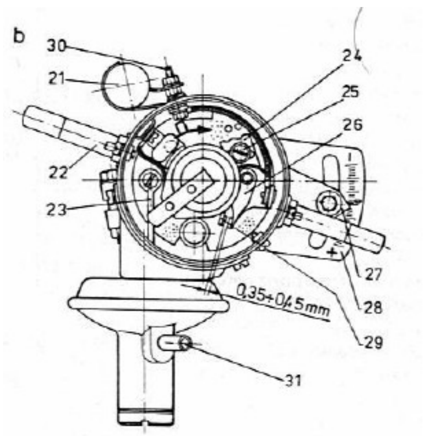
7.18 Figure: METHOD OF INSTALLATION OF THE IGNITION DISTRIBUTOR IN THE S-21 ENGINE

7.3.1 S-21 engine ignition circuit

	Ordinary ignition	Electronic ignition
Type of distributor	44-44 ZELMOT	4484 ZELMOT
Ignition advance angle (static)	8 ± 1°	7 ± 1°
Transmission: camshaft - ignition distributor shaft	2:1	2:1
Short-circuit angle of the interrupter contact	65 ± 4°	-
Ignition sequence in cylinders	1-2-4-3	1-2-4-3
Interrupter contact spacing	0,35...0,45 mm	-
Contact clamping force	5,3...6,4 N	-
Durability of the distributor	100000 operating hours	100000 operating hours
Mass of the distributor	1,35 kg	1,50 kg
Order number of the distributors	4444.7.000.5	
Requirements and tests	BN-80/3682-03	
Ignition coil	BE 200B	4426
Primary coil resistance (20°C)	3,2 Ω	0,7...0,86 Ω
Secondary winding resistance	6,25...8,25 kΩ	8,40...11,55 kΩ
Solenoid discharge current	4,5 A	5,6 A
Coil weight	0,9 kg	1,0 kg
Voltage generated by the coil	approx. 15 kV	approx. 19 kV
Spark energy (according to PN-73/S-76105)	approx. 30 mJ	approx. 60 mJ
Spark plugs	F75	F75
Capacity of capacitor	0,20...0,25 μF	-
Pads spacing	0,6...0,7 mm	1,0 mm
Durability of candles	15000 km	15000 km
Electronic module	-	GL-118

7.12 Table: CHARACTERISTICS OF THE S21-ENGINE IGNITION SYSTEM



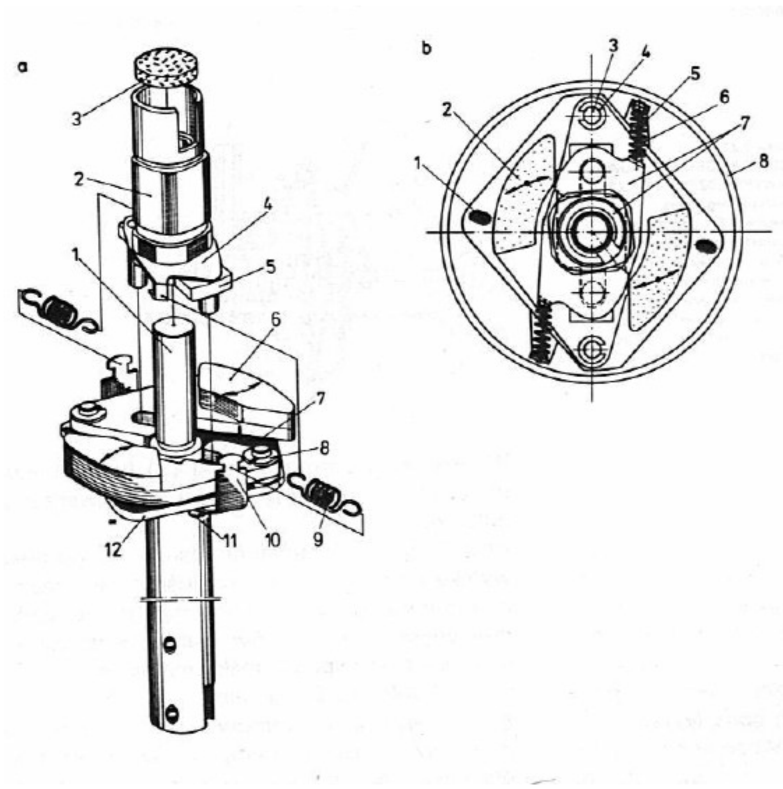


a - budowa
b - demontaż (opis wg 7.19)
1 - glowica, 2 - szczotka palca (elektroda), 3 - elektroda głowicy, 4 - palec rozdzielacza, 5 - wkladka filcowa smarowania rozdzielacza, 6 - płytka, 7 - regulator odśrodkowy, 8 - podkładki regulacyjne, 9 - tulejka łożyskowa, 10 - korpus. 11 - podkładka regulacyjna, 12 - kołek sprężysty, 13 - sprzęgiełko. 14 - walek napędowy, 15 - gniazda przewodów zapłonowych, 16 - wałek górny. 17 - tulejka z krzywkami. 18 - przerywacz, 19 - gniazdo smarowania rozdzielacza, 20 - śruba mocowania, 21 - kondensator, 22 - uchwyt głowicy. 23 - cięgno regulatora podciśnieniowego, 24 - płytka regulacyjna przerywacza, 25 - wkręt regulacyjny, 26 - styk ruchomy (mloteczek). 27 - wskazówka regulatora oktanowego, 28 - płytka regulatora oktanowego, 29 - styk stały (kowadełko), 30 - zacisk przewodu zasilania, 31 - regulator podciśnieniowy

7.19 Figure: IGNITION DISTRIBUTOR (44-44) (ROZDZIELACZ ZAPŁONU)

a - construction
b - disassembly (description according to 7.19)
1 - head, 2 - finger brush (electrode), 3 - head electrode, 4 - distributor finger, 5 - distributor lubrication felt pad, 6 - plate, 7 - centrifugal regulator, 8 - adjustment washers, 9 - bearing sleeve, 10 - housing. 11 - adjusting washer, 12 - spring pin, 13 - coupling. 14 - drive shaft, 15 - ignition cable sockets, 16 - top shaft. 17 - cam bushing. 18 - interrupter, 19 - distributor lubrication socket, 20 - fixing screw, 21 - capacitor, 22 - head handle. 23 for the string of the vacuum regulator, 24 for the interrupter control plate, 25 for the control screw, 26 for the movable contact (milled cups). 27 - pointer of the octane regulator, 28 - plate of the octane regulator, 29 - fixed contact (anvil), 30 - terminal of the supply line, 31 - vacuum regulator

■ The octane regulator is used to mount the ignition distributor to the engine and to manually adjust the ignition preview angle, depending on the type of fuel used. By loosening the fixing screw (20) and turning the distributor body clockwise (-), the ignition preview angle is reduced, and in the opposite direction to the rotation of the shaft (+), the ignition preview angle is increased. The direction of rotation (n) of the distributor is indicated by the arrow (Fig. 7.19).



7.20 Figure: CENTRIFUGAL CONTROL OF THE IGNITION ADVANCE ANGLE (REGULATOR ODŚRODKOWY KĄTA WYPRZEDZENIA ZAPŁONU)

a - construction
1 - distributor shaft, 2 - bushing with cams, 3 - felt pad, 4 - plate with spring catches, 5 - plate with weights, 6 - weight, 7 - regulator insulation plate, 8 - settling ring. 9- spring vigour. 10 - spring clip. 11 - screw. 12 - weight plate
b - top-down view
1 - the regulator plate, 2 - the weight, 3 - the weight axis, 4 - the settling ring, 5 - the pulling spring of the weights, 6 - the spring clip. 7 - bushing with cams and regulator plate, 8 - housing of the distributor

a - budowa
1 - wałek rozdzielacza, 2 - tulejka z krzywkami, 3 - wkladka filcowa, 4- płytka z zaczepami sprężyn, 5 - płytka z zabierakami ciężarków, 6 - ciężarek, 7 - płytka izolacyjna regulatora, 8 - pierścień osadczy. 9- spreżyna. 10 - zaczep sprężyny. 11 - wkręt. 12 - płytka z ciężarkami
b - widok z góry
1 - płytka regulatora, 2 - ciężarek, 3- oś ciężarka, 4 - pierścień osadczy, 5 - sprężyna ściągająca ciężarki, 6 - zaczep sprężyny. 7 - tulejka z krzywkami i płytką regulatora, 8 - obudowa rozdzielacza

The task of the ignition advance regulators is to ignite the fuel mixture in the engine cylinders at the most appropriate moment depending on the engine load.

■ The centrifugal regulator (Fig. 7.20) consists of a plate (12) pressed onto the distribution shaft (1), in which two axes (8) of the regulator's weights (6) are seated.

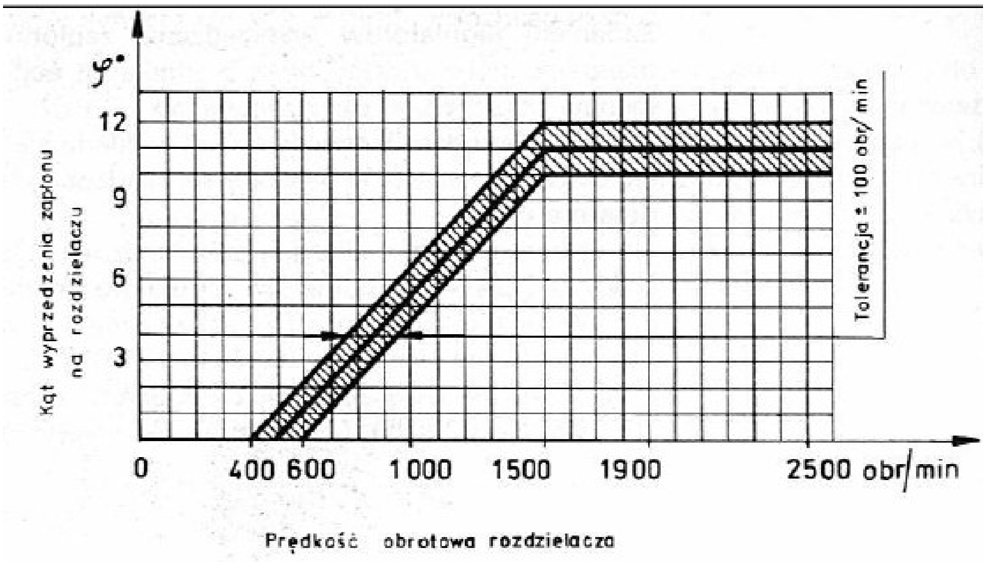
On the top of the shaft (1) there is a sleeve (2) with cams for the interrupter and a movable plate (5) of the regulator, fixed by a press on the sleeve (2). Two pins are pressed into the controller plate (5), which enter the oval holes of the swivelable weights (6).

The plate (4) has two catches, to which two springs (9) are attached, pulling the sleeve (2) with the cams of the interrupter.

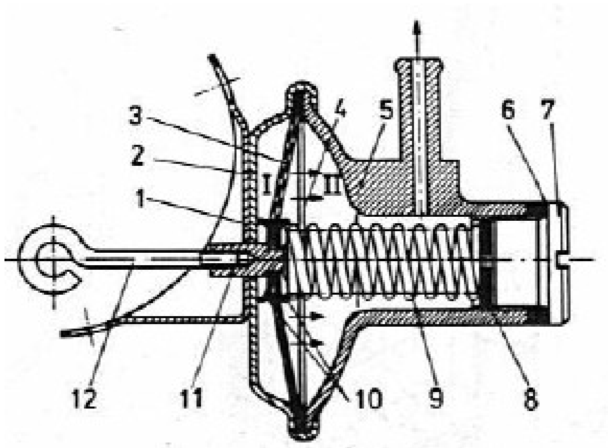
The centrifugal control device is located in the ignition distributor body made of aluminium alloy. During engine operation, the rotating weights (6) swing out under centrifugal force and press on the moving plate (5), rotate it with the cam (2) in relation to the plate (12) and the shaft (1), overcoming the tensile force of the springs (9) until it equilibriums.

The balance between the centrifugal force of the weights and the spring tension corresponds to each speed. Due to the selected curves of the arms with an increase in the engine speed, the weights (6)

rotate the plate (5) together with the cam (2, Fig. 7.20) in relation to the ignition distributor shaft (1), so that the interrupter contacts are opened earlier, and thus the ignition of the mixture in the engine cylinders takes place earlier.



7.21 Figure: CHARACTERISTICS OF THE CENTRIFUGAL CONTROLLER



7.22 Figure: VACUUM REGULATOR TIMING OF THE IGNITION ADVANCE

1 - controller bracket. 2 - cover, 3 - membrane, 4 - membrane gasket. 5 - body, 6 - crank seal, 7 - threaded plug, 8 - adjustment washers, 9 - spring, 10 - steel cups, 11 - rod and membrane connector. 12 - control string

1 - wspornik regulatora. 2 - pokrywa, 3 - membrana, 4 - uszczelka membrany. 5 - korpus, 6 - uszczelka korbka, 7 - korek gwintowany, 8 - podkładki regulacyjne, 9 - sprężyna, 10 - miseczki stalowe, 11 - łącznik cięgna i membrany. 12 - cięgno regulatora

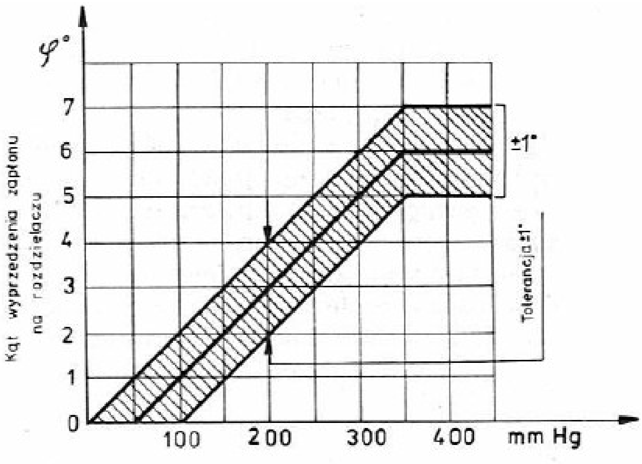
The value of the cam rotation angle (2) in relation to the ignition distributor shaft (1) depends on the rotational speed of this shaft and on the force of the regulator springs (9).

The characteristics of the centrifugal governor are shown in Figure 7.21. As the diagram shows, the centrifugal governor starts operating at an engine speed of 800 rpm (the crankshaft revolutions of the engine are twice as high as those of the ignition distributor shaft) and accelerates the ignition preview angle by a maximum of 10.. 12° at engine speed 3000...4000 rpm.

■ The vacuum regulator (Fig. 7.22) consists of a body and a diaphragm connected to the interrupter control rod. The diaphragm is pressed against the base by a cylindrical spring with a fixed threaded plug, thus forming a vacuum chamber, connected to the carburettor by a flexible pipe.

The difference between the atmospheric pressure and the vacuum in the carburettor generates a force on the membrane which, by overcoming the spring force with a pull rod, pulls the interrupter plate, accelerates the moment of interruption in the low voltage circuit. The maximum vacuum

(46,6 kPa) is obtained when the carburettor throttle is opened at an angle of 45° (halfway). When the throttle valve is opened more widely, the vacuum decreases and the vacuum regulator is closed when fully opened, but the engine speed is then so high that the centrifugal regulator operates.



7.23 Figure: CHARACTERISTICS OF THE VACUUM REGULATOR

The breaker (18, Fig. 7.19) consists of a fixed contact with the anvil (29) and a mobile contact with the hammer (26). The anvil has an additional notch for adjusting the contact distance between the screw (25) and the eccentric head. The rotary hammer has a riveted tungsten contact with the bird spring and the power cord. A tannin adjacent to the interrupter cam is formed on the tissue. The cam working surface (17) is ground and polished to reduce friction and wear. The roller is lubricated with a felt insert periodically saturated with engine oil.

The power cord for the hammer contact is connected to a terminal on the breaker that is isolated from the housing to which the ignition coil voltage is applied. The capacitor cable (21) is also connected to this terminal. To protect the interrupter contacts from sparks, a parallel capacitor (21) is connected which increases the high voltage of the ignition coil secondary winding, reduces wear on the interrupter contacts and extends the duration of the spark discharge for better combustion of the mixture.

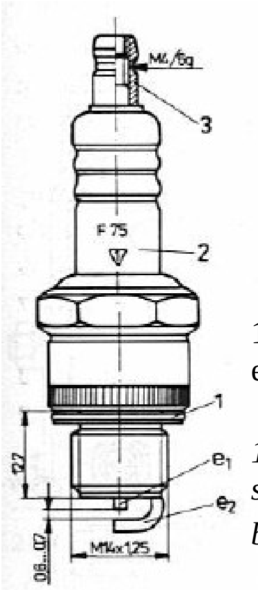
The finger of the ignition distributor (4), made of bakelite with a pressed electrode made of brass tape, is placed on the cam.

The ignition distributor is covered from above with a bakelite angle distributor head (1) with five sockets for the high-voltage cable terminations. The brass side electrodes of the head are turned so that the rotating finger passes by them with its electrode with a small clearance. In this way, the high voltage current generated in the ignition coil flows through the carbon contact to the distributor finger, from where it enters the socket via the brass electrode. The head is mounted on the camera body with two flat springs. The characteristics of the vacuum regulator are shown in Figure 7.23.

Spark plugs

Spark plugs F75 are used for the S-21 motor (Fig. 7.24). The steel body of the candle is ended with an M14x1,25 thread for screwing into the head socket.

The candle insulation is made of special porcelain, resistant to high temperatures and increased pressure. All motor-mounted spark plugs shall be of the same type and manufactured by one manufacturer. Other spark plugs may also be used, as shown in Table 7-13.



1 - copper gasket, 2 - candle F75, 3 - contact nut (M4x0,7). e_1- middle electrode, e_2 - side electrode

1 - uszczelka miedziana, 2 - świeca F75, 3 - nakrętka stykowa (M4x0,7). e_1- elektroda Środkowa, e_2 - elektroda boczna

7.24 Figure: SPARK PLUG F75 (WIECA ZAPŁONOWA)

The heat value of a candle determines the heat dissipation capacity of a candle. Spark plugs F75 (cold) have a high heat value, they do not heat up well due to their high heat dissipation capacity. Hot plugs have a lower heat value, become more hot, but are more self-cleaning. Under difficult operating conditions (high heat load), F80 spark plugs with a higher thermal value can be used instead of F75 spark plugs (as an alternative).

Thread dx1	**Spark plug and manufacturer**				
	Iskra Poland	**Bosch** Federal Republic of Germany	**Mogurt** Hungary	**Katek USSR**	**Marelli Italy**
M14 x 1,25 25 x 12,7 (1/2”)	F75	W175T1	V-30	A23	CW225N CW6N

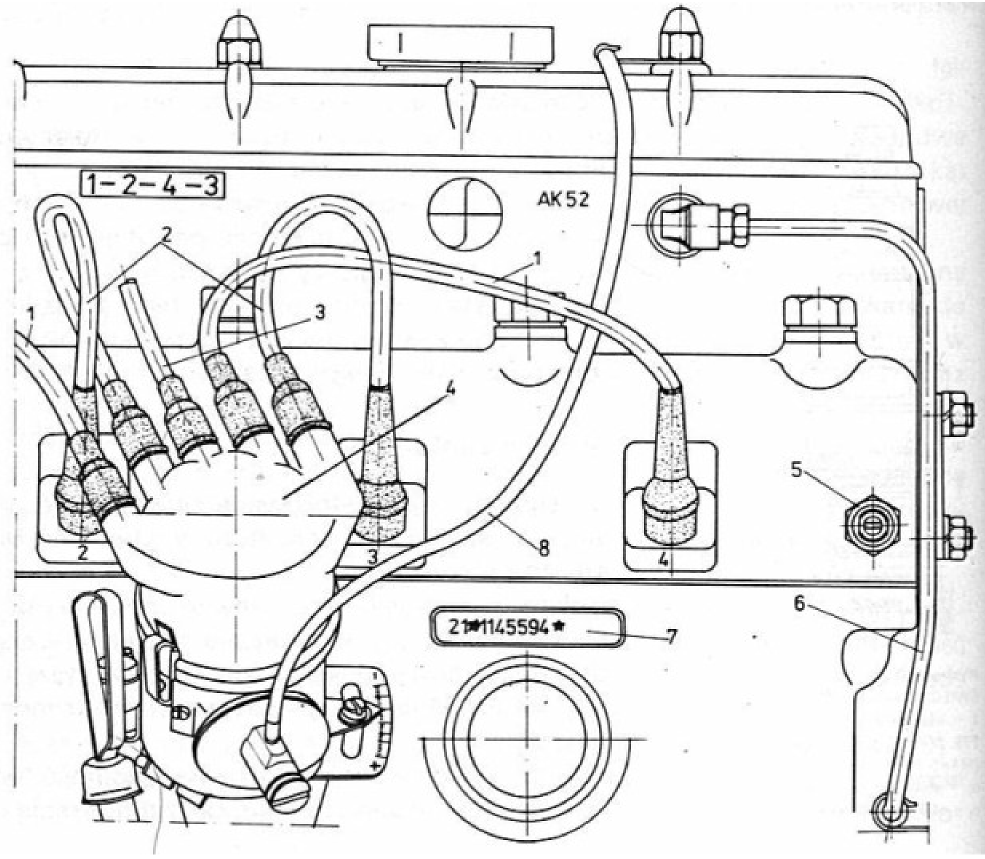
7.13. Table: REPLACEMENT SPARK PLUGS FOR ENGINE S-21

Ignition cables

Ignition cables (Fig. 7.25) are characterized by high insulation resistance and special construction. The textile rope is covered with a ferromagnetic plastic sheath made of 0.11 mm diameter wire made of nickel-iron conductor (spiral) and an external insulation sheath made of polyvinyl with an external diameter of 7 mm.

Rubber caps are fitted to the cable ends to protect the spark plugs, coil sockets and spark plug head sockets from moisture and dust. The candle tips are clamped on the wires. Check the condition and mounting of the hoses on the engine while the vehicle is in operation. The ignition cable glands

must be in good contact with the ignition distributor head sockets, the ignition coil and the candles. Moisturised ignition cables cause current to flow to earth and make it difficult or impossible for the motor to start up. In addition, broken insulation can cause the ignition cables to malfunction, resulting in leakage of current to earth. Clean dirty or corroded cable ends and replace damaged insulated cables. Ignition cables shall not come into contact with metal parts of the engine which are hot or have sharp edges.



1 - ignition cable: distributor-candles 1. and 4. of the cylinder, 2 - ignition cable: distributor-candles 2. and 3. of the cylinder, 3 - ignition cable: ignition coil-distributor. 4 - ignition distributor, 5 - engine temperature sensor, 6 - lubrication system pipe, 7 - engine serial number, 8 - vacuum regulator pipe: carburettor-ignition distributor, 1-2-4-3 - ignition sequence.

1 - przewód zapłonowy: rozdzielacz-świece 1. i 4. cylindra, 2 - przewód zapłonowy: rozdzielacz-świece 2. i 3. cylindra, 3 - przewód zapłonowy: cewka - rozdzielacz zapłonu. 4 - rozdzielacz zapłonu, 5 - czujnik temperatury silnika, 6 - przewód układu smarowania, 7 - numer fabryczny silnika, 8 - przewód regulatora podciśnieniowego: gaźnik-rozdzielacz zapłonu, 1-2-4-3 - kolejność zapłonu .

7.25. Figure: INSTALLATION OF ENGINE S-21 IGNITION CABLES

Repair of engine S-21 ignition contact circuit

The ignition circuit failure is given in table 7-14. The ignition switch shall not be repaired. Remove the damaged one from the steering column after cutting the screws (1) fixing the cover (2) to the housing (5) (fig. 7.14).

The breaker may be detected by disconnecting the electrical wires from the breaker and shorting them directly to close the circuits in order:

- the cable from the "30" connector with the cable from the "15/54" connector; the function of the receivers must be checked at this connection;
- the cable from the "30" connector with the cable from the "50" connector; the starter unit should be in operation for this connection.

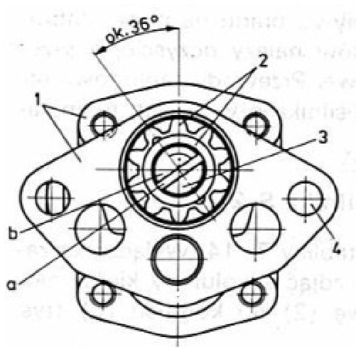
If the receivers operate with the wires disconnected and shorted, and you connect them to the switch and turn the key to the "1" GAR or "2" GO position, the ignition switch is defective.

To check the condition of the ignition coil, check its resistance, including its insulation resistance, and then measure the spark length (min. 12 mm) at an ambient temperature of 15°C to 25°C.

The low voltage circuit shall have an active resistance of 3,1 ... ...3.4 Ω and high voltage circuit resistance 8.25...8.75 kΩ. The coil head, tested at 500 V, shall have a minimum resistance of 50 MΩ between the terminals and the coil housing. A coil that does not meet these requirements must be replaced. The coil and the cables should be well fixed and clean. When mounting the coil, ensure that the supply cable (connector "1") and the cable to the ignition interrupter (connector "16") are properly connected. This must be done with care so that the gear does not catch on the hole wall and rotate. The oil pump gear wheel (2) with screw teeth, when completely interlocked with the camshaft gear, turns slightly clockwise (viewed from the ignition distributor side) and takes the position (b) as indicated in Figure 7.26. The oil pump gear (3) with screw teeth can also be used as an accessory to the camshaft gear.

Trouble	Reasons	Method of repair
1. The ignition circuit does not work	1.1. The ignition switch does not turn the current into a low voltage circuit.	1.1. Replace the faulty ignition switch.
	1.2. Damaged capacitor (shorting or puncturing insulation).	1.2. Replace the damaged capacitor.
	1.3. The spacing of the chopper contacts is too small.	1.3. Adjust the contact gap to 0,35 ... 0,45 mm and clean them.
	1.4. No voltage at the movable contact due to shorting of the chopper power supply terminal by the flame.	1.4. Check the condition of the chopper clamp isolation and replace the damaged (pierced) insulation washers of the bushing.
	1.5. No spark due to high voltage current breaks to ground, short-circuits or punctures in the coil windings, no contact at the low voltage terminals, cracking of the coil head or chipping.	1.5. Clean the dirty and damp coil. In the event of head damage or short-circuit in the winding - replace the coil with a new one.
	1.6. Chopper contacts burned.	1.6. Remove overburning and raids at the contacts, replace damaged contacts with new ones, check and replace the capacitor if necessary.
2. Excessively loud operation of the ignition device	2.1. Overly worn roller of the ignition distributor.	2.1. Replace the worn bushing.
	2.2. Excessively worn weight pins of the centrifugal regulator.	2.2. Replace worn parts.
	2.3. Weakened or improperly adjusted springs of the centrifugal regulator.	2.3. Replace the springs or adjust the spring latches.
	2.4. Excessive pressure of the breaker hammer (which causes increased wear of the tungsten contacts).	2.4. Replace the hammer spring or the complete hammer

7.14. Table: ENGINE S-21 IGNITION CONTACT TROUBLESHOOTING



7.26. Figure: INSTALLATION OF THE OIL PUMP IN THE ENGINE

1 - pump casing, 2 - gear wheel, 3 - pump drive shaft. 4 - fixing holes for the pump a - initial setting of the shaft with the channel, b - correct setting of the roller after rotation by an angle of 30

1 - korpus pompy, 2 koło zębate, 3 - walek napędowy pompy. 4 - otwory mocowania pompy a - ustawienie początkowe wałka z kanałkiem, b - ustawienie właściwe walka po obrocie o kąt 30

Alignment of the ignition distributor in the engine. Position the fin of the ignition distributor shaft (a, Fig. 7.27) horizontally so that it can be inserted into the channel (b) the oil pump roller set as in Figure 7.26.

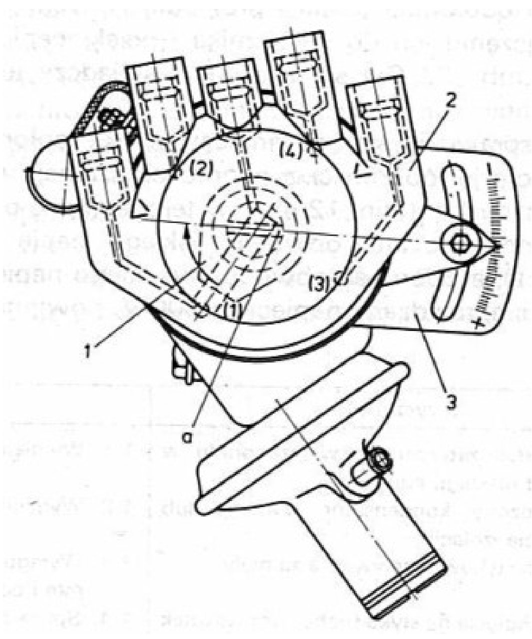
The finger of the ignition distributor (1) shall then be in front of the contact (electrode) of the first cylinder of the ignition distributor head (Fig. 7.27). In this position, carefully insert the ignition distributor into the hole in the engine hull and make sure that the distributor finger (1) rotates slightly to make sure that the distributor shaft fin has reached the oil pump shaft channel (Fig. 7.26). To determine the ignition distributor, tighten the screw on the engine (20, Fig. 7.19).

Checking and adjusting the contact distance of the interrupter. To check the contact spacing of the interrupter, please proceed as follows:

- remove the head (1) and the ignition distributor finger (see Fig. 7.19),
- check the contacts for burning and clean if necessary with a small flat file,
- by turning the crankshaft (this is done by the other person using the crank handle), set the cam (17) of the ignition distributor to the position giving the greatest contact opening,
- check with a crevice gauge the contact distance of the interrupter, which should be 0.35...0.45 mm.

If the distance is incorrect, adjust it as follows:

- loosen the screw (25 fig. 7.19) of the interrupter and insert the screwdriver into the slotted plate (24), push it to the required distance between the interrupter contacts,
- tighten the screw (25) and check the distance again with a thickness gauge,
- put on your finger (4) and head (1).



7.27. Figure: INSTALLATION OF THE IGNITION DISTRIBUTOR IN THE ENGINE

1 - finger of the separator, 2 - head, 3 - mounting plate of the separator with octane regulator scale a - required position of the fins of the separator shaft when the background of the 1. cylinder is 5 ± 1° in front of the GM

1 - palec rozdzielacza, 2 - głowica, 3 - płytka mocowania rozdzielacza ze skalą regulatora oktanowego a - wymagane położenie płetwy wałka rozdzielacza przy położeniu tloka 1. cylindra 5 ± 1° przed ZZ

After each adjustment of the spacing between the interrupter contacts, the ignition timing must be checked and, if necessary, adjusted.

The most common maintenance procedures for the ignition circuit are the adjustment and setting of the ignition in the engine. This is done after the ignition distributor has been installed (e.g. repaired) in the engine, camshaft, oil pump or if the engine is not functioning correctly.

The factory sets the ignition preview angle to 8 ± 1° by adjusting the S-21 engine to ethyl 86.

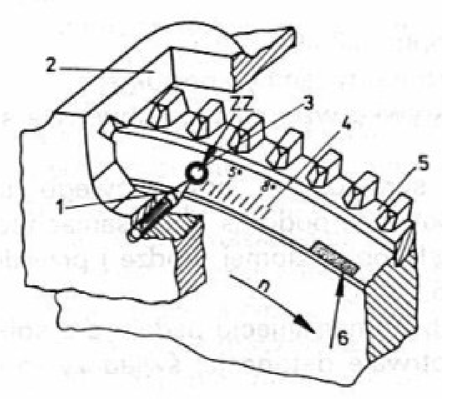
Installation of an ignition distributor on the engine. The ignition distributor is driven together with the oil pump by the engine camshaft (Fig. 7.18), therefore the oil pump must be correctly installed before it is installed (when it was removed, e.g. for repair).

This is done as follows. Set the crankshaft of the engine so that the piston of the first cylinder is in the outer travel (ZZ) of the compression stroke. Turn the oil pump shaft so that the cut-out for coupling to the ignition distributor shaft follows the line (a) in Figure 7.26 before inserting it into the engine hull bore so that the pump flange is correctly positioned in relation to the overflow flange on the engine hull.

Checking the ignition advance angle. The ignition is checked and adjusted during vehicle maintenance (OT) (Tables 8-6); after installation of the ignition distributor in the engine, camshaft, oil pump and in case of engine malfunctions such as

- reduction of acceleration, maximum vehicle speed and engine power,
- knocking combustion,
- engine overheating,
- increase fuel consumption.

The engine ignition is checked and set to the position of the piston rod of the first cylinder in the ZZ external turn (both valves are closed). In this position, the conical pin (1, Fig. 7.28), pressed into the coupling casing, shall be opposite the mark (3) drilled into the flywheel.



1 - index pin, 2 - clutch housing, 3 - inspection mark (hole), 4 - graduation, 5 - motor flywheel, 6 - warning mark in white. ZZ - piston external turn, n - direction of rotation of crankshaft and flywheel

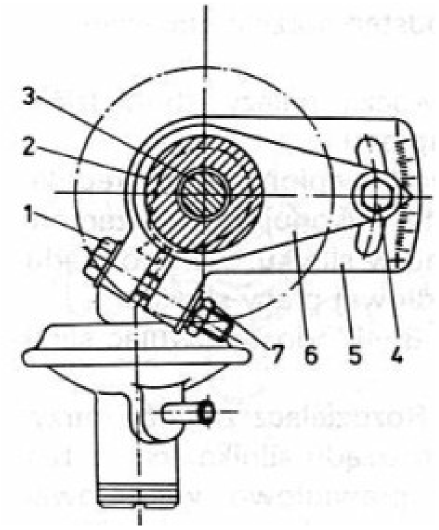
1 - kołek wskazujący, 2 - obudowa sprzęgła, 3 - znak kontrolny (otworek), 4 - podziałka, 5 - koło zamachowe silnika, 6 - znak ostrzegawczy malowany białą farbą. ZZ - zwrot zewnętrzny tłoka, n - kierunek obrotów walu korbowego i koła zamachowego

7.28. Figure: THE POSITION OF THE PISTON AND CYLINDER WHEN ADJUSTING THE IGNITION

To check the setting of the ignition preview angle, please proceed as follows:

- remove the cover of the flywheel sight glass on the coupling casing (2, Fig. 7.28);

- remove the ignition distributor head (note the position of the ignition cable of the first cylinder spark plug);
- connect the control lamp (with a 10 W filament lamp) with one cable to the low-voltage isolated terminal (30) of the ignition distributor (as shown in Fig. 7.19) and the other to the motor ground;
- switch on the engine ignition;
- turn the crankshaft (this is done by the second person with the crank handle) until the distributor finger (on the side of the steel plate with the head) is in front of the cylinder's candle holder and the conical pin (1, fig. 7.28) in the sight glass hole indicates an angle of 8° before the check mark (3) on the flywheel, which marks the position of the piston rod of the first cylinder in ZZ.



7.29. Figure: REQUIRED ARRANGEMENT OF THE IGNITION DISTRIBUTOR COMPONENTS WHEN SETTING THE IGNITION

1 - screw, 2 - ignition distributor body, 3 - ignition distributor roller. 4 - screw, 5 - mounting plate of the distributor with octane regulator scale, 6 - pointer, 7 - nut

1 - śruba, 2 - korpus rozdzielacza zapłonu, 3 - walek rozdzielacza zapłonu. 4 - śruba, 5 - płytka mocowania rozdzielacza ze skalą regulatora oktanowego, 6 - wskazówka, 7 - nakretka

In this position, the light bulb of the tell-tale shall illuminate when the ignition advance angle is correctly set. If it does not light up, adjust the engine's ignition preview angle.

Ignition setting. In order to set the ignition advance angle, it is necessary to:

- set the pitch on the flywheel to a position indicating an angle of 8° forward of ZZ, the distributor finger being in front of the hose holder of the first cylinder candle;
- release the nut (7, fig. 7.29), the attachment of the plate (5) to the distributor body, keeping the central position of the pointer (6) on the scale;
- adjust the correct ignition setting by turning the distributor body without loosening the screw (4); the correct ignition setting is understood as the beginning of the opening of the interrupter contacts in the position of the first cylinder piston corresponding to its angle by ZZ; the beginning of the opening of the interrupter contacts is signalled by the BTS lighting up the control lamp; the correctness of the adjustment is checked by turning the finger of the distributor to the left, with the lamp turning off at the end of the finger position and back on

again after releasing the finger; - tighten the nut (7, Fig. 7.29). Then check that the ignition setting is correct. To do this, turn the crankshaft slowly (this is done by the second person with the crank handle) and stop exactly at the moment when the control lamp lights up in the position of the distributor finger (1, as shown in Fig. 7.27)

- in front of the holder (socket) of the first cylinder cable, in the distributor head;
- check that the pointer in the flywheel sight glass (Fig. 7.28) is set at 8° by the AS; if there is any discrepancy, check the ignition setting; the maximum ignition displacement is permitted to be 0 ± 1° from the nominal value in order to avoid detonation burning;
- switch off engine ignition;
- disconnect the control lamp cables;
- replace the sight glass cover on the coupling casing and the ignition distributor head.

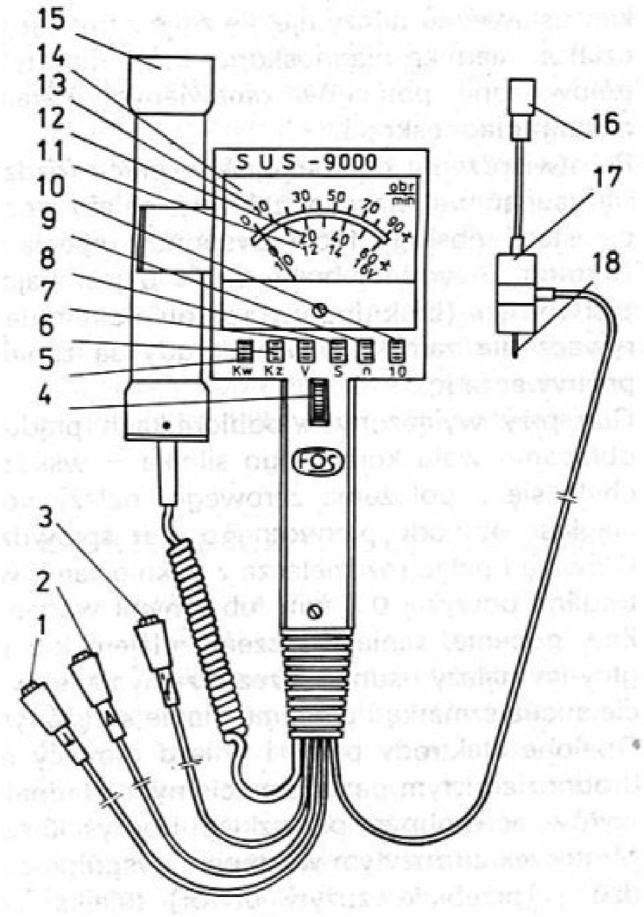
The final check for the correct ignition setting of the S-21 engine can be made when driving on the third run in a self-taught manner at 55...60 km/h, on a horizontal road and with the engine warmed up to 75...85°C.

If the accelerations occur as far as the stop is concerned when the pedal is depressed quickly:

- weak short-term detonations, which indicates correct ignition setting,
- in case of strong detonations, the ignition should be delayed,
- in the absence of detonation, the ignition should be accelerated.

In the event of a change in the octane number of the fuel used, the control shall be carried out by means of the octane regulator.

(5, Figure 7.28), in which the acceleration is indicated by a sign (+) and the ignition deceleration by a sign (-) are indicated. After loosening the screw (4) which holds the ignition distributor, you can turn the plate (5) together with the distributor body (2) to the right or to the left (ignition acceleration or deceleration).



1 - a jaw holder connected to the vehicle ground, 2 - a jaw holder connected to the power supply clamp, 3 - a jaw holder SUS -9000 connected to the terminal of the primary ignition coil winding. 4 - knob for changing the phase of light of the stroboscope, 5 - switch "Kw" for switching on the measurement of the ignition advance angle, 6 - switch "Kz" for switching on the measurement of the breaker contact short-circuit angle, 7 - switch "V" for switching on the measurement of the battery charging voltage, 8 - switch "S" for switching on the measurement allowing the evaluation of the breaker contacts, 9 - switch "n" for switching on the measurement of the engine rotational speed. 10 - switch "10" for switching on the change of the speed measurement range. 11 - graduation for reading the battery charging voltage, 12 - graduation for reading the short-circuit angle of the contacts of the 6-cylinder motor breaker, 13 - graduation for reading the short-circuit angle of the contacts 4-cylinder and 2-cylinder engine interrupter and engine speed (also used to read out the ignition preview angle), 14 - indicator board. 15 - stroboscopic probe, 16 - socket, 17 - transformer, 18 - tip for socket

1 - uchwyt szczękowy podłączony do masy samochodu, 2 - uchwyt szczękowy podłączony do zacisku zasilania, 3 - uchwyt szczękowy SUS -9000 podłączony do zacisku uzwojenia pierwotnego cewki zapłonowej. 4 - pokrętło do zmiany fazy świecenia stroboskopu, 5 - przełącznik "Kw" do włączania pomiaru kąta wyprzedzenia zaplonu, 6 - przełącznik "Kz" do włączania pomiaru kąta zwarcia styków przerywacza, 7 – przełącznik "V" do włączania pomiaru napięcia ładowania akumulatora, 8 - przełącznik "S" do włączania pomiaru umożliwiającego ocenę styków przerywacza, 9 - przełącznik "n" do włączania pomiaru prędkości obrotowej silnika. 10 - przełącznik "10" do włączania zmiany zakresu pomiaru predkości obrotowej. 11 - podzialka do odczytu napiecia ladowania akumulatora, 12 - podziałka do odczytu kata zwarcia styków przerywacza silników 6-cylindrowych, 13 - podziałka do odczytu kąta zwarcia styków
przerywacza silników 4 i 2-cylindrowych oraz prędkości obrotowej silnika (służy też do odczytania kąta wyprzedzenia zaplonu), 14 - tablica wskaźnikowa. 15 - sonda stroboskopowa, 16 - nasadka, 17 - transformator, 18 - końcówka do nasadki

7.30. Figure: STROBOSCOPIC AUTOMOTIVE DEVICE SUS-9000

Movement of the control plate (5) by one plot corresponds to a change of the ignition preview angle by 2°.

Checking the ignition setting is much faster, simpler and more accurate using a diagnostic tool, type SUS-9000, with a weight of 1 kg (Fig. 7.30). It is powered from the battery of the tested car. The device can also be used to make diagnostic measurements of the following engine operating parameters (section 7.3.3.):

- breaker contact short-circuit angle,
- static ignition preview angle at idle speed,
- battery charging voltage,
- engine running,
- evaluation of the quality of the interrupter contacts.

To measure the ignition preview angle, adjust the engine idling speed. Connect the cables of the diagnostic tool as follows:

- put the hose with the socket on the candle of the first cylinder,
- connect the cable, marked with the interrupter symbol, to the low voltage circuit of the ignition coil on the interrupter side,

- connect the cable, marked with "A", to a low voltage installation, preferably to the primary terminal of the ignition coil winding on the power supply side,
- connect the cable, marked with the "earth" symbol, to the metal part of the motor,
- start the engine,
- turn on the stroboscopic device by directing the flashing light at the flywheel sight glass.

The knob, which causes the stroboscope to change its phase of illumination, should be turned so that the sign on the flywheel (hole) coincides with the blade of the pin, pressed into the clutch casing (fig. 7.28). This setting must read the measured ignition preview angle on the scale of the Diagnoscope Meter, which must be 8 ± 1° for Ethanol 86. For a detailed description of the measurement of these parameters, refer to the Diagnostics Manual.

If you find that the ignition distributor is not working properly, have it checked and adjusted by a service station that has special equipment, such as the Crypton type. The reason for the lack of ignition is usually a break in the primary circuit (no power supply from the battery); this occurs when the breaker does not close the circuit, when the breaker contacts are oily or corroded, etc.

If, with the current consumers switched off - after the ignition is switched on and the crankshaft of the engine rotates - the ammeter's pointer does not deviate from the zero position, the wires and continuity of the primary circuit must be checked successively and the contacts must be checked (Table 2-21). The head and finger of the distributor must be replaced with new ones with cracks, chippings, worn out electrodes above 0,3 mm or other defects. Any moisture, oil or carbon contamination on the head must be removed by washing it with technical gasoline, wiping it off with a dry cloth and blowing it off with compressed air.

The tanned electrodes of the finger and the distributor head sockets can be cleaned with fine-grained abrasive paper. Still burning contacts of the interrupter should be smoothed with a small file and cleaned with a cloth dampened in petrol.

A hammer with a worn out projection, cam and damaged (puncture, worn hole) insulating sleeve should be replaced with a complete breaker.

Replace the vacuum regulator with a new one if it is leaking. Lubrication of the distributor shaft (16, Fig. 7.19) consists in periodical saturation of the felt insert (5) with several drops of engine oil, after removing the head and through the hole in the body, after removing the screw (19).

Spark plugs are operated by periodically cleaning the outer surface of the insulator, checking the condition of the insulator (cracks, chipping), checking the tightness of the seat and the distance between electrodes. Avoid prolonged idling of the engine and a slow car ride in third gear, as carbon deposits and soot on the surface of the candle when it is running. Such a dirty working surface of the candle soaks up with fuel, causes a puncture to the mass and makes it difficult for the engine to start. Uneven engine performance in different vehicle gears, engine breaks and vibrations are evidence of the malfunctions of the spark plugs. To check which candle is running intermittently or not at all, the temperature of the insulators of the candles must be compared. Candles with a lower insulator temperature do not work properly; they must be unscrewed, checked

for condition, and the insulator and electrodes cleaned. Replace the spark plugs (domestic) with new ones after 15 000 km of driving.

The distance between the electrodes of the candles must be checked. If necessary, the distance is adjusted by bending or bending the side electrode. A wire gauge should be used to check the distance between the electrodes of the candle, as a simple plate gauge cannot be used to measure the distance correctly. Candles with melted electrodes above 0.3 mm and plugs showing cracks or blows between the insulator and the housing must be replaced.

The appearance of the inner part of the insulator allows conclusions to be drawn,

Concerning the operating conditions of the engine candle. Isolator, brightly coated

The design of the inner part of the insulator allows conclusions to be drawn about the operating conditions of the engine candle. The insulation, which is light brown in colour and has a shiny grey surface on the electrodes, indicates that the candle is working properly. Isolator covered with black greasy soot, shows excessive amount of oil entering the combustion chamber, as a result of wear and tear of engine components. Dry black soot on the insulator indicates that the carburettor is not properly adjusted (rich mixture). An insulator cone, clean and dry, white in colour, and a dry and grey candle body chamber, with yellow-coloured streaks, indicate that the mixture is too poor or the ignition is poorly set.

Candles covered with carbon deposits should be cleaned with a wire brush or by sandblasting, then the candles should be washed with non-ethylised petrol and dried with a stream of air. Do not burn the carbon on the candle, as the internal stresses of the candle will disappear and the candle will break down. Motor candles must be screwed in with a torque of 25...30 N·m.

7.3.2 Electronic ignition circuit

In Żuk cars with S-21 engine electronic ignition was also introduced (as version II). For this purpose, an ignition distributor, an ignition coil and an electronic module from the Polonez 1600 were used.

The use of this ignition (with inductive discharge) enables:

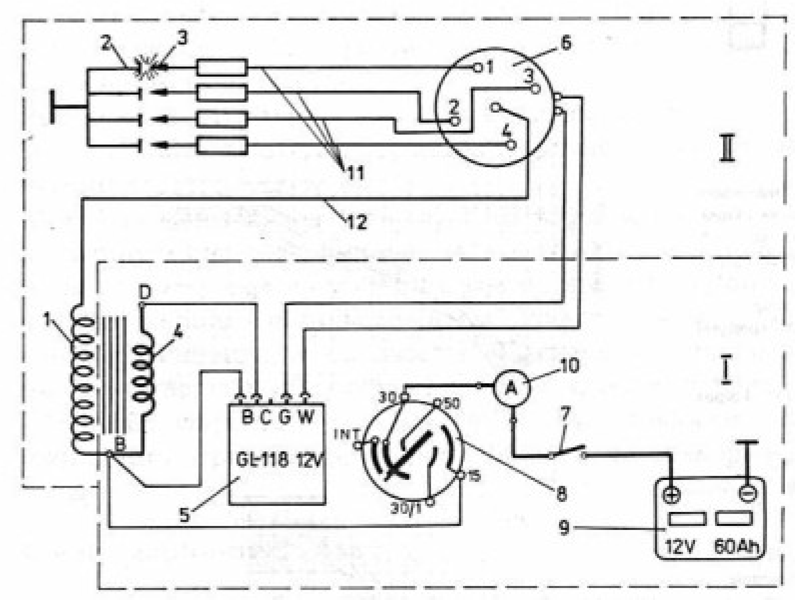
1) high energy production of the electric discharge on candles,

2) independence of the voltage in the secondary circuit of the ignition coil from the voltage drop in the primary circuit,

3) limitation of the control of the ignition circuit,

4) maintaining constant performance throughout the service life.

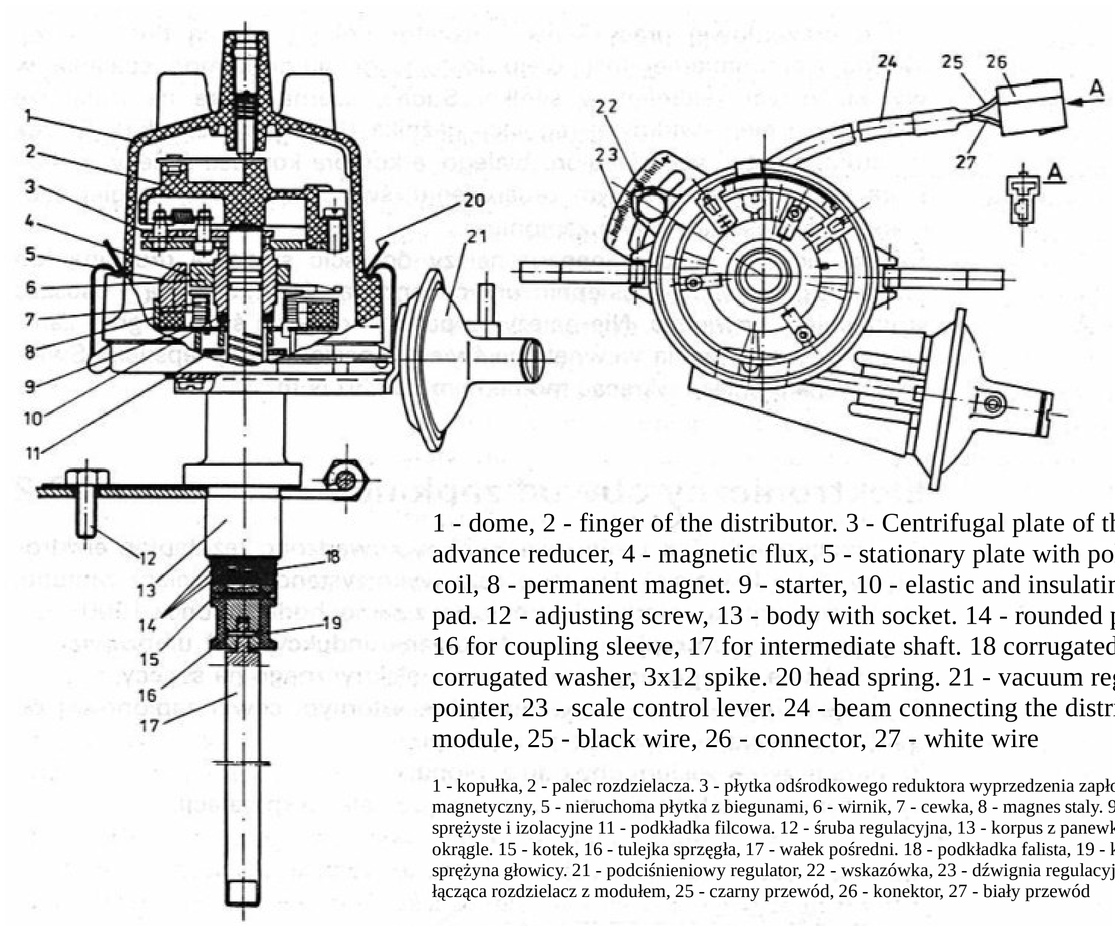
7.3.2 Electronic ignition circuit



1 - secondary coil winding, 2 - motor, 3 - spark plugs. 4 primary coil winding, 5- electronic module. 6 - ignition distributor, 7 - battery switch, 8 - ignition switch. 9 - battery, 10 - ammeter, 11.12 - ignition cables
I - low voltage circuit.
II - high voltage circuit

1 - uzwojenie wtórne cewki, 2 - silnik, 3 - świece zapłonowe. 4 uzwojenie pierwotne cewki, 5- modul elektroniczny. 6 - rozdzielacz zapłonu, 7 - odlacznik akumulatora, 8 - wylacznik zapłonu. 9 - akumulator, 10 - amperomierz, 11,12 - przewody zapłonowe
I - obwód niskiego napięcia.
II - obwód wysokiego napięcia

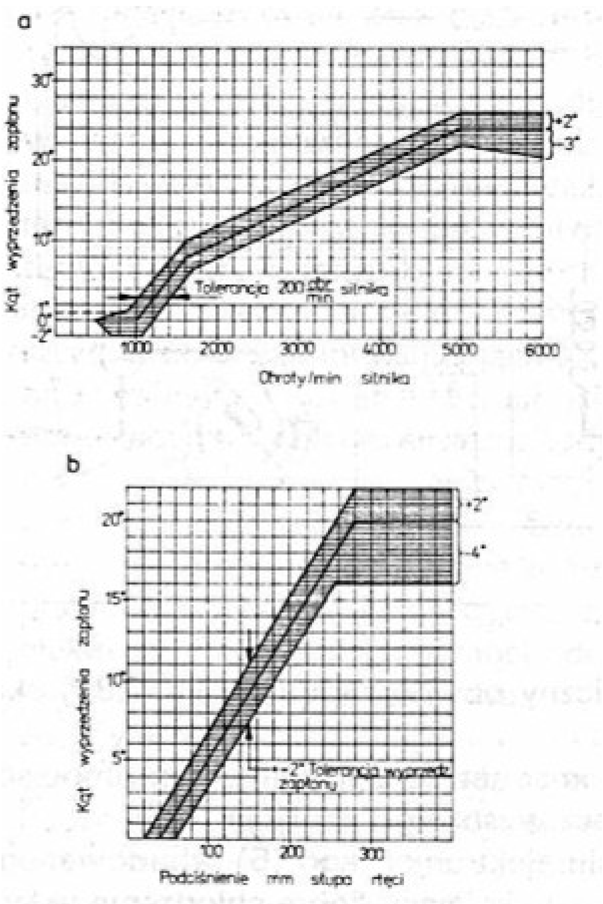
7.31. Figure: ELECTRONIC IGNITION DIAGRAM



1 - dome, 2 - finger of the distributor. 3 - Centrifugal plate of the ignition advance reducer, 4 - magnetic flux, 5 - stationary plate with poles, 6 - rotor, 7 - coil, 8 - permanent magnet. 9 - starter, 10 - elastic and insulating pads, 11 - felt pad. 12 - adjusting screw, 13 - body with socket. 14 - rounded pads. 15 for cat, 16 for coupling sleeve, 17 for intermediate shaft. 18 corrugated washer, 19 corrugated washer, 3x12 spike. 20 head spring. 21 - vacuum regulator, 22 - pointer, 23 - scale control lever. 24 - beam connecting the distributor with the module, 25 - black wire, 26 - connector, 27 - white wire

1 - kopułka, 2 - palec rozdzielacza. 3 - płytka odśrodkowego reduktora wyprzedzenia zapłonu, 4 - strumień magnetyczny, 5 - nieruchoma płytka z biegunami, 6 - wirnik, 7 - cewka, 8 - magnes staly. 9 - starter, 10 - podkładki sprężyste i izolacyjne 11 - podkładka filcowa. 12 - śruba regulacyjna, 13 - korpus z panewkami. 14 - podkladki okrągle. 15 - kotek, 16 - tulejka sprzęgła, 17 - wałek pośredni. 18 - podkładka falista, 19 - kolek 3x12. 20 - sprężyna głowicy. 21 - podciśnieniowy regulator, 22 - wskazówka, 23 - dźwignia regulacyjna ze skalą. 24 - wiązka łącząca rozdzielacz z modułem, 25 - czarny przewód, 26 - konektor, 27 - biały przewód

7.32. Figure: ELECTRONIC IGNITION DISTRIBUTOR (ELEKTRONICZNY ROZDZIELACZ ZAPŁONU)



a - characteristics of the centrifugal controller of the contactless ignition distributor
b - characteristics of the vacuum regulator of the non-contact ignition distributor

a - charakterystyka regulatora odśrodkowego bezstykowego rozdzielacza zaplonu
b - charakterystyka regulatora podciśnieniowego bezstykowego rozdzielacza zapłonu

7.33. Figure: CHARACTERISTICS OF THE CONTACTLESS IGNITION DISTRIBUTOR

The electronic ignition circuit (Figure 7.31) consists of the following components:

- an electromagnetic pulse generator, which is built into a high voltage distributor (6),
- an electronic module (5) integrated in an aluminium finned heat sink for good cooling of the electronic system,
- an ignition coil (1,4),
- an ignition distributor (6),
- spark plugs (3),
- an ignition (8) switch,
- battery (9).

The characteristics of the engine's electronic ignition system S-21 (and that of the normal system) are given in Table 7-12.

This setup has the following advantages:

- elimination of the mechanical breaker and all associated malfunctions such as wear and tear, burning of the contacts, wiping of the cam and tappet on the contacts and changes in the setting of the ignition phases,
- minimum current consumption at engine idling speed,

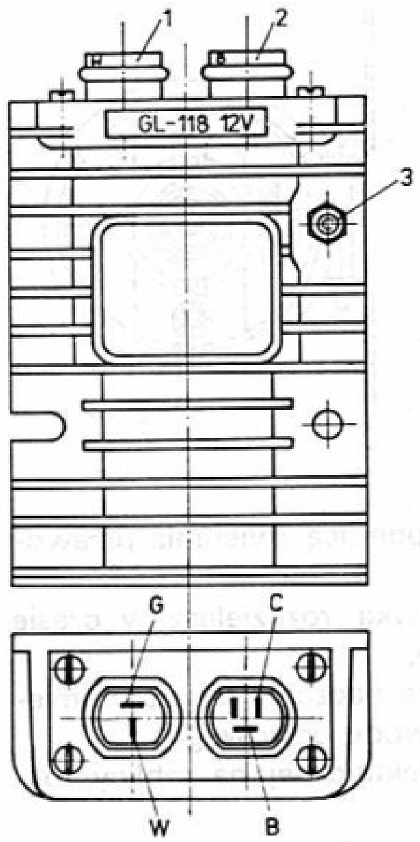
- minimum changes in secondary voltage as a function of the ambient temperature of the supply voltage and the motor speed,
- high secondary voltage to allow the spark to jump between the electrodes of the spark plug at a distance of 1 mm,
- spark duration of more than 2 ms,
- possibility of using a poorer fuel-air mixture due to higher ignition energy,
- no battery power when the engine is not running and the ignition key is in the ignition (GO) position.

Electronic ignition distributor (4484)

This distributor differs from the mechanical one in that of a pulse generator. The pulses are generated by a winding (Fig. 7.32) in a magnetic field (4) with an alternating air gap.

The magnetic field runs from the permanent magnet (8), through the stationary plate with the pole (5), the rotor (6), the distributor shaft (17), and the starter (9). The rotor (6) with its four poles is permanently connected to the plate of the centrifugal anti-ignition device (3). During rotation, it interrupts the magnetic field line (4), causing a change in the magnetic flux. Changing the flow causes an impulse in the winding (7).

This pulse is sent to the electronic module (Fig. 7.34). The automatic change of the ignition advance as a function of the engine speed and vacuum in the carburettor line is performed in the same way as in the contact device. Similarly, the high voltage is distributed in the same way as in the case of the contact ignition distributor by means of the distributor head and finger.



7.34. Figure: ELECTRONIC IGNITION MODULE (ELEKTRONICZNY MODUL ZAPŁONOWY)

1.2 - plug connector sockets. 3- screw G.W - plug connector connector for connection to the ignition distributor, B.C - plug connector connector connector for connection to the ignition coil. GL - 118, 12 V - type of module

1.2 - gniazda złącz wtykowych. 3- śruba G.W - końcówka zlacza wtykowego do połączenia z rozdzielaczem zapłonu, B.C - końcówki złącza wtykowego do połączenia z cewka zapłonowa. GL - 118, 12 V - typ modułu

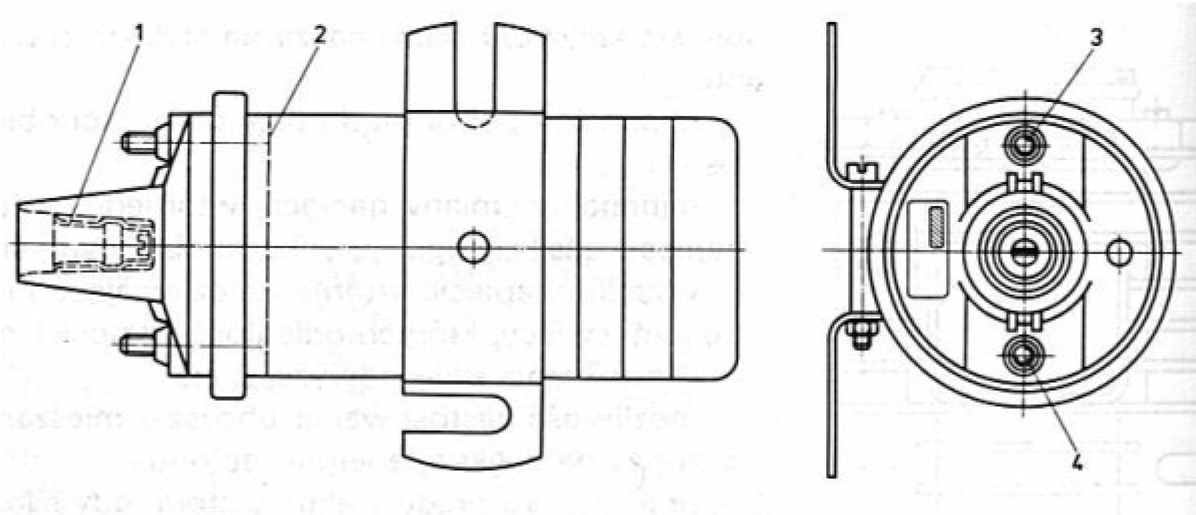
Electronic module

The module controls the primary circuit of the ignition coil by means of electronic integrated circuits (4, Figure 7.31). The pulses in the primary circuit induce high voltage in the secondary circuit (1). Integrated circuits of the electronic module are placed in a sealed .casing inside the heat sink, and their task is to maintain constant parameters in changing conditions in the range of temperature -35...+125°C. The system is equipped with filters to eliminate diffuse and conductive radio interference. The heat sink requires a perfect connection to the ground.

Ignition coil (4426)

The ignition coil (Fig. 7.35) is oil insulated and has an open magnetic circuit, and differs from the coil to the contact system only by its electrical parameters. The resistance of the primary winding at

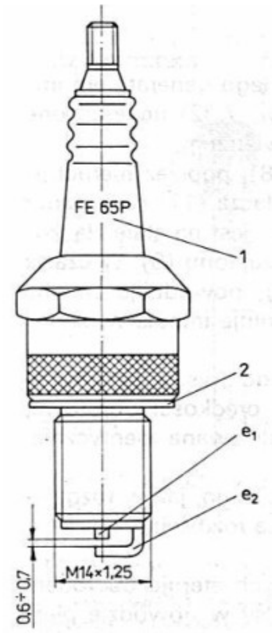
20°C is 0.70...0.86 Ω, the resistance of the secondary winding is 8.40...11.55 k Ω. Due to the high voltage in the secondary winding of the ignition coil (over 19 kV), the ignition cables are shielded. Spark plugs F75 are as shown in Figure 7.36.



7.35. Figure: IGNITION COIL 4426 (CEWKA ZAPŁONOWA 4426)

1 - ignition cable socket. 2 - oil level, 3.4 - supply line connectors

1 - gniazdo przewodu zapłonowego. 2 - poziom oleju, 3,4 - złącza przewodów zasilania



7.36. Figure: SPARK PLUG (ŚWIECA ZAPŁONOWA)

1 - candle, 2 - gasket, e_1 - middle electrode, e_2 - side electrode

1 - świeca, 2 - uszczelka, e_1 - elektroda Środkowa, e_2 - elektroda boczna

Verification of electronic ignition

Due to the high energy consumption of the system, the following instructions should be followed carefully when checking the system, as improper inspection of the system may result in electric shock or irreparable damage to the entire system.

7.3.2 Electronic ignition circuit

Not applicable:

- check the voltages and currents at the connections with a short circuit (spark),
- disconnect the high voltage coil-distributor cable while the motor is running, even when the motor is starting,
- connect the low voltage terminals of the rotating coil to the ground (the end is connected to the brown wire),
- start the motor when the electrical connections on the dashboard are not connected,
- supply the ignition circuit when the module is not connected to ground or when the connection is not working,
- use diagnostic instruments that could cause a short-circuit in a low voltage circuit (solenoid and tachometer primary circuit).

A static current voltmeter and an ohmmeter are required for the control of the electronic system.

Start by checking that the electrical wiring harness is securely fastened and that the ignition distributor-module plug connector (Fig. 7.34) is pressed in as far as it will go and that good electrical conductivity is ensured. When the ignition is switched on, check that the electrical wiring is secure and in good condition and that the connection between the module, motor hull and battery negative terminal is in good condition. The resistance of the connections shall not exceed 0,2 Ω. When the ignition is on and the engine is not running, check the ignition circuit power supply using a voltmeter. To do this, check the voltage at the +B terminal of the ignition coil (Fig. 7.31). It shall be equal to the battery voltage (approx. 12 V). The voltage at the terminal (D) shall not be more than 0.3 V below the voltage at the +B terminal.

If other values are found, the primary winding shall be checked (resistance), which shall be 0,70...0,86 Ω.

Verification of the function of the ignition circuit:

- remove the high-voltage cable from one candle and position the free end not at a distance of approx. 5 mm from the motor hull,
- start the engine and check that the spark jumps between the lines as a weight,
- repeat this procedure for the other high-voltage cables each time by switching the motor off and back on again.

If there is no spark, check the function of the distributor.

> Do not interrupt the connection between the high voltage socket of the ignition coil and the ignition distributor while checking and do not touch or disconnect the ignition cables while the engine is running.

The function of the ignition distributor must be checked with the ignition switched off as follows:

- disconnect the plug connectors (22, fig. 7.32) of the connecting cable between the distributor and the module,
- connect the ohmeter to the terminal (G, plug connector) and measure the winding resistance of the pulse generator, which shall be 700...800Ω.
- remove the ignition distributor dome and check the air gap between the rotor (6) and pole (5), which must be 0.3... ...0,4 mm,
- check the finger resistance of the distributor, which shall be 5000 Ω,
- check that the screw (3, Fig. 7.34) is screwed in as far as it will go.

If the test results do not show any faults and the ignition does not work, the electronic module will be damaged. If the ignition distributor or the oil pump was removed during the engine repair, the ignition timing must be checked. When checking this angle, connect one wire of the stroboscopic lamp (see Fig. 7.30) to the candle of the first cylinder and the other two wires to the battery poles. Connecting the ignition terminals to the ignition coil may damage the stroboscopic lamp.

The correct ignition preview angle shall be 7 ± 1°. If the ignition preview angle is not correct, set it as described in section 7.3. The electronic ignition distributor does not require lubrication or adjustment.

7.3.3 Engine CB ignition circuit (PN 1600)

CB engines (PN 1600) with ordinary (contact) ignition or electronic (contactless) ignition are to be installed in "ŻUK" cars (from 01.07.1992).

The contact circuit of the CB engine shall be the same as that of the S-21 engine (as shown in Figure 7.15) and the electronic ignition circuit shall be the same as shown in Figure 7.31. The characteristics of the CB engine ignition systems are given in Table 7-13.

The design of the CB ignition distributor and the spark plug and ignition coil is similar to that of the S-21 engine, whereas in the CB engine's electronic ignition circuit the ignition coil and the electronic module are the same and the ignition coil differs only in the design of the drive shaft.

In the CB engine, the shaft is connected to the oil pump by means of multi-gears and in the S-21 engine by means of a claw coupling (fins).

The operation, adjustment and repair of the CB motor ignition circuit (contact and electronic) must be carried out as described in sections 7.3.1 and 7.3.2, observing the parameters required for a CB motor (Tables 7-15).

7.3.3 Engine CB ignition circuit (PN 1600)

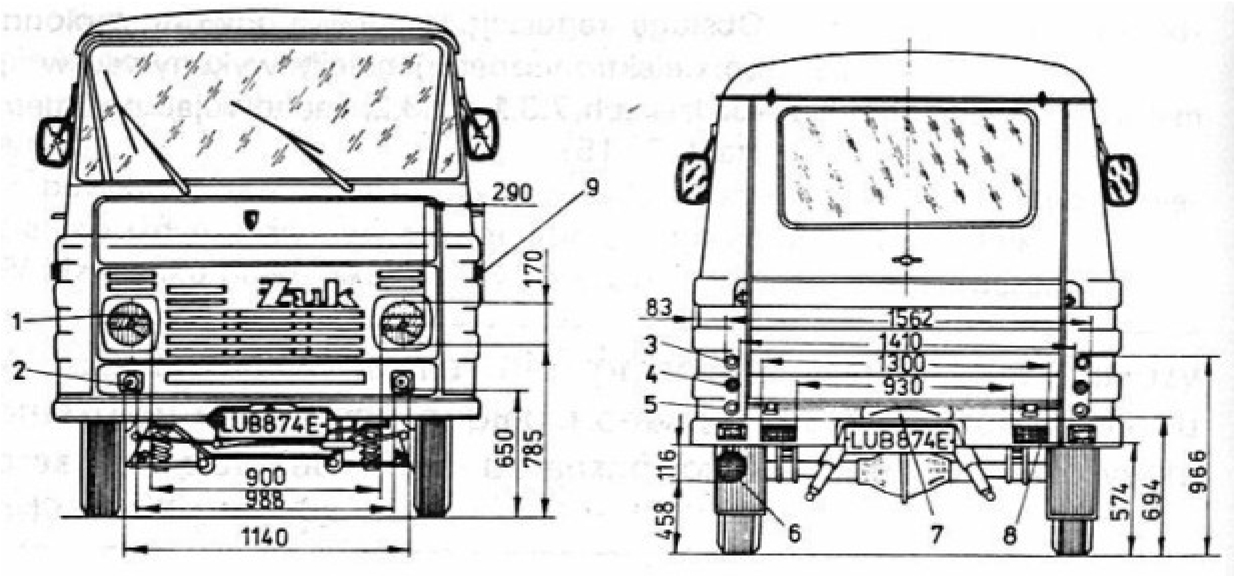
	Ordinary ignition	**Electronic ignition**
Type of distributor	4492 ZELMOT	4498 ZELMOT
Ignition advance angle (static)	9...11°	7 ± 1°
Transmission: camshaft - ignition distributor shaft	2:1	2:1
Short-circuit angle of the interrupter contact	52...58°	-
Ignition sequence in cylinders	1-3-4-2	1-3-4-2
Interrupter contact spacing	0,42...0,48 mm	-
Contact clamping force	4...5 N	-
Durability of the distributor	10000 operating hours	10000 operating hours
Mass of the distributor	1,35 kg	1,5 kg
Requirements and tests	BN-80/3682-03	
Electronic module	-	GL-118
Ignition coil	BE 200B	4426
Primary coil resistance (20°C)	3,1 ÷ 3,4 Ω	0,7 ÷ 0,86 Ω
Secondary winding resistance	6,75 ÷ 8,25 kΩ	8,40 ÷ 11,55 kΩ
Solenoid discharge current	4,5 A	5,6 A
Spark energy of coil	30 mJ	30 mJ
Voltage generated by the coil	approx. 15 kV	approx. 19 kV
Coil weight	0,9 kg	1,0 kg
Spark plugs	Iskra FE65P	Iskra FE65P
Pads spacing	0,6...0,7 mm	1,0 mm
Candle thread	M14 x 1,25	M14 x 1,25
Durability of the candle	15000 km	15000 km
Capacity of capacitor	0,20...0,25 μF	-

7.15. Table: CHARACTERISTICS OF THE CB ENGINE IGNITION SYSTEM

7.4 LIGHTS

7.4 LIGHTS

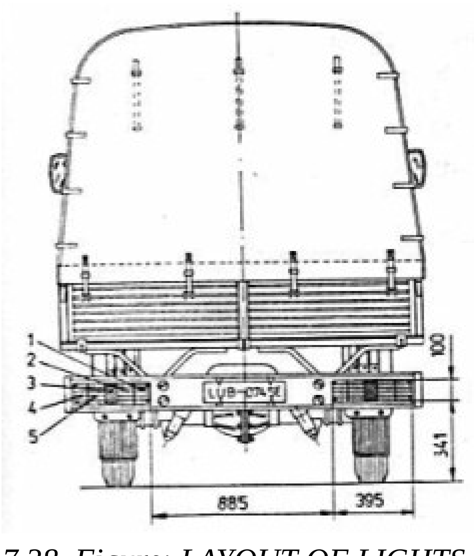
Żuk car is equipped with external and internal lights (Fig. 7.37, 7.38).



7.37. Figure: VANS LAYOUT OF THE LIGHTS

1 - headlamp (position, passing, driving), 2 - direction indicator and hazard lamp lamps, 3 - direction indicator and hazard lamp lamps, 4 - reflex reflectors, 5 - rear and brake lamp, 6 - rear fog lamp (red), 7 - registration plate lamp. 8 - reversing lamp, 9 - side indicator lamp for direction indicators and emergency lights (yellow).

1 - reflektor (światła pozycyjne, mijania, drogowe), 2 - lampa świateł kierunkowskazów i awaryjnych przednich, 3 - lampa świateł kierunkowskazów i awaryjnych tylnych, 4 - Światła odblaskowe, 5 - lampa świateł pozycyjnych tylnych i hamowania ..stop", 6 - lampa przeciwmgłowa tylna (czerwona), 7 - lampa oświetlenia tablicy rejestracyjnej. 8 - lampa światla cofania, 9 - lampka boczna światel kierunkowskazów i awaryjnych (żółta).



1 - anti-fog lamp, 2 - reversing lamp, 3 - retro-reflecting element. 4 - direction indicator lamp, 5 - position and stop lamps

1 - światło przeciwmgłowe, 2 - Światło cofania, 3 - element odblaskowy. 4 - światło kierunkowskazu, 5 - światła pozycyjne i hamowania "stop"

7.38. Figure: LAYOUT OF LIGHTS IN A111, A161 BOX CARS

External lights (according to PN-82/S-73010) include lights:

- lighting (road, passing, front and rear fog and reversing);
- signal (position), braking, stop, direction of travel, emergency flashing and parking (position);
- identification (registration plate);
- retro-reflective (rear).

7.4 LIGHTS

Exterior lamps are intended to illuminate the road or the environment of a car and to provide information concerning that car to other road-users.

The dimensions shown in the drawings refer to an unladen vehicle according to PN-81/S-73029.

The interior lights of the car are:

- cab interior lighting lamp (passenger compartment),
- control panel lighting lamp.

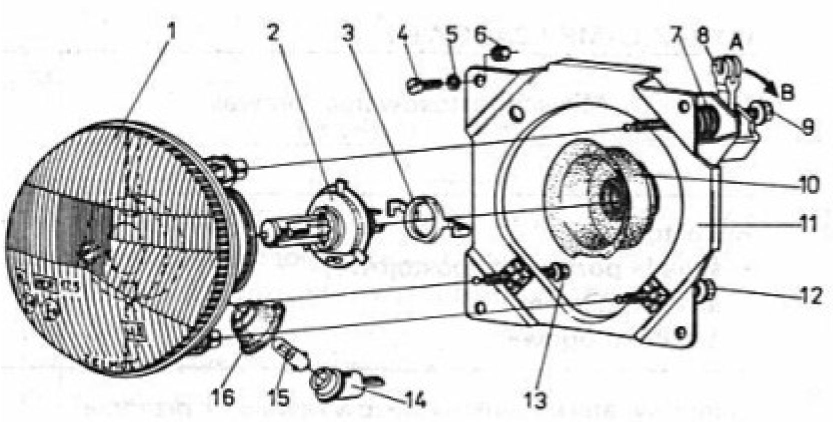
A list of lamps and filament lamps is given in Table 7-16.

Place of use of light bulbs	Filament lamp power (W)	Vehicle variety
Headlamps: - Position (parking) lamps - passing lamps - main-beam headlamps	60/55 4 55 60	all varieties
Direction indicator lamps and hazard warning signal lamps front	21	
Lights for side direction-indicator lamps	4	
Rear position lamp lamps, and stop lamps	21/5	vans
Rear direction-indicator lamps and hazard warning signal lamps	21	
Retro-reflectors	-	
Rear fog lamp	21	all varieties
Reverse-lamp lamps	21	
Registration plate lamp	5	vans and containers
Grouped rear lamps: - position lamps and registration plate lamps - stop-lamp' stop-lamp - direction indicator and hazard warning signal lamps - reflectors - reversing lamps - rear fog lamps	 10 21 21 - 21 21	box cars, isothermal cars and containers
Front fog lamps Flashlights	55 55	fire-fighting vehicles
Cab interior lighting lamps	10	all varieties
Lighting lamp for the interior of the cargo compartment	10	vans and containers
Portable lamp	10	all varieties
Test lights (7 pcs.)	2	in fire-fighting vehicles 9 pcs.

7.16. Table: LIST OF LAMPS AND LIGHT BULBS

7.4.1 Headlamps

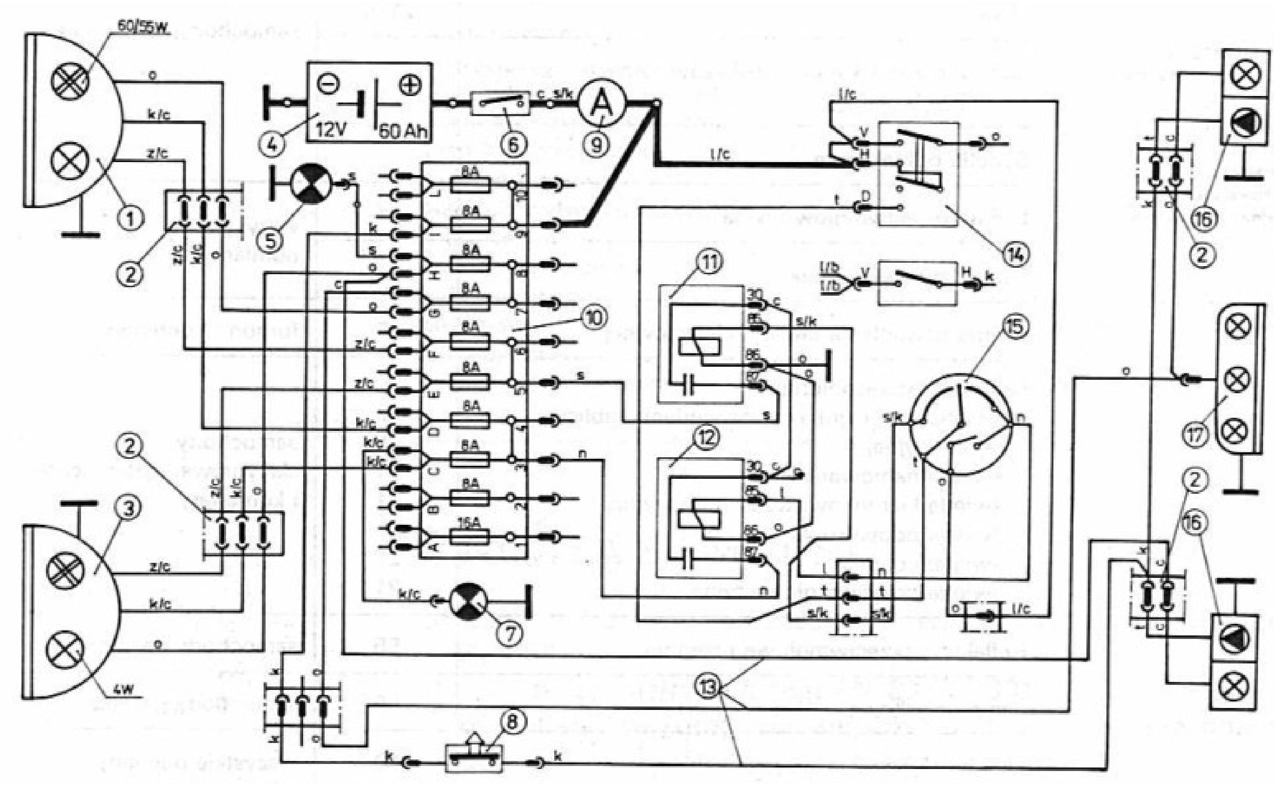
Żuk cars are equipped with round headlamps type 0252. They have levers, separate for each headlamp, for the adjustment of dipped-beam headlamps according to the vehicle load (manually adjustable at standstill).



1 - optical element, 2 - passing beam and driving beam filament lamp (60/55 W). 3 - spring of bulb mounting, 4 - screw M6x12, reflector mounting. 5 - washer, 6 - nut M6. 7 - spring, 8 - lever (equalizer) for light adjustment, 9 - screw for adjusting the lights in a vertical plane. 10 - bulb housing, 11 - complete housing, 12 - horizontal adjustment screw. 13 - headlamp lever position screw, 14 - filament lamp holder, 15 - position lamp bulb (4 W). 16 - filament lamp cover

1 - element optyczny, 2 - żarówka świateł mijania i drogowych (60/55 W). 3 - sprężyna mocowania żarówki, 4 - wkręt M6x12, mocowania reflektora. 5 - podkładka sprężysta, 6 - nakrętka M6. 7 - sprężyna, 8 - dźwignia (korektor) regulacji świateł, 9 - Śruba regulacji świateł w płaszczyźnie pionowej. 10 - osłona żarówki, 11 - obudowa kompletna, 12 - śruba regulacji świateł w płaszczyźnie poziomej. 13 - śruba położenia dźwigni reflektora, 14 - oprawka żarówki, 15 - żarówka świateł pozycyjnych (4 W). 16 - oslona żarówki

7.39. Figure: HEADLAMPS



7.40. Figure: LAMPS WIRING DIAGRAM

1 - right headlamp, 2 - plug connector, 3 - left headlamp, 4 - battery, 5 - control lamp for position lights, 6 - battery disconnector, 7 - main-beam headlamp control lamp, 8 - brake lamp switch, "stop". 9 - charging current indicator (ammeter). 10 - fuse box, 11 - passing beam relay, 12 - driving beam relay, 13 - electric wires. 14 - switch for external lights (positional, dipped, traffic lights). 15 - main-beam switch, 16 - rear lamp with position and braking lamps, 17 - registration plate lamp

1 - reflektor prawy, 2 - złącze wtykowe, 3 - reflektor lewy, 4 - akumulator, 5 - lampka kontrolna światel pozycyjnych, 6 - odłącznik akumulatora, 7 - lampka kontrolna świateł drogowych, 8 - włącznik świateł hamowania „stop". 9 - wskaźnik prądu ladowania (amperomierz). 10 - skrzynka bezpieczników, 11 - przekaźnik świateł mijania, 12 - przekaźnik świateł drogowych, 13 - przewody elektryczne. 14 - przełącznik świateł zewnętrznych (pozycyjne, mijania, drogowe). 15 - przełącznik świateł drogowych, 16 - lampa tylna ze światłem pozycyjnym i hamowania, 17 - lampa oświetlenia tablicy rejestracyjnej

■ The reflector (Fig. 7.39) consists of a complete housing (11) with sockets for three bolts with spherical end. The optical element (1) has spherical snap-on sockets for mounting the reflector on the screws of the plate. The upper seat of the screw is equipped with a cam mechanism for stepless adjustment of the position of the optical element. The headlamp-levelling levelling device shall have two positions:

- position "A" - the vehicle is unladen,
- position "B" - fully loaded car.

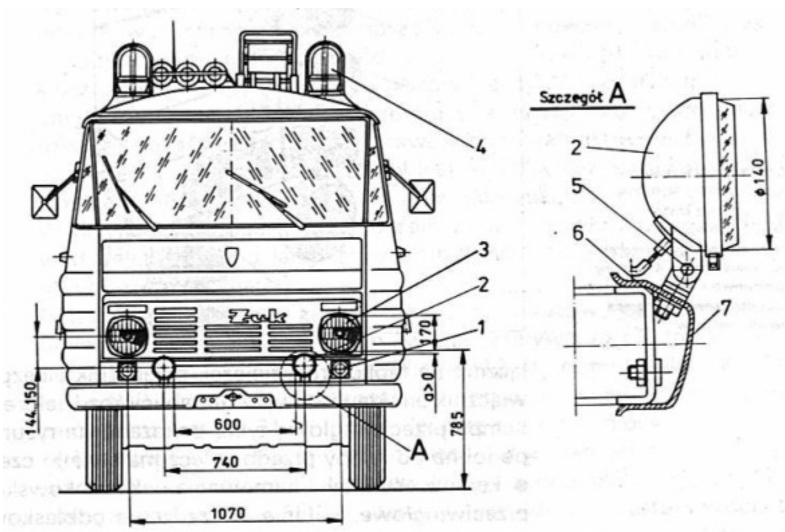
The hand stops (8, Fig. 7.39) must be set uniformly in both headlamps in position 'A' or 'B' depending on the vehicle load.

A diagram of the electrical connection of the headlamps is shown in Figure 7.40. The headlamps are powered by an alternator or battery (when the vehicle is stationary) by a key switch (14) on the dashboard, a main-beam switch (15) on the steering column and fuses 8 A, placed in the box (10) below the dashboard. There is a parallel control lamp (7) connected to the main-beam headlamp circuit in parallel, located on the indicator board. When the main-beam headlamps are switched on, the indicator light illuminates blue.

Two filament lamps are installed in the headlamp: one double filament lamp with a power of 60/55 W (main-beam and dipped-beam) and the other 4 W (position lamps). The glass is permanently glued to the mirror and rolled over with a rim. The reflector housing (11, Fig. 7.39) of sheet steel protects the reflector from the inside. The reflector with glass (1) is attached to the housing (11) by three screws, two of which are also used to adjust and position the lamps vertically or horizontally.

The reflector of the spherical-shaped reflector is made of sheet steel and sprayed aluminium.

7.4.2 Vehicle exterior lamps



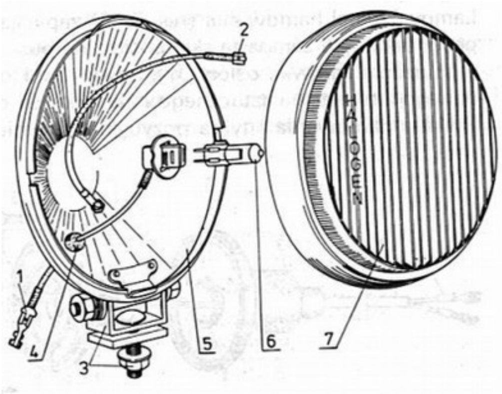
7.41. Figure: FOG LAMPS IN FIRE-FIGHTING VEHICLES

1 - direction indicator lamp, 2 - fog lamp, 3 - reflector, 4 - flash lamps, 5 - screw for fixing the reflector. 6 - nut, 7 - car front bumper,
a - distance of the edge of the lens of the fog lamp from the optical element of the main-beam headlamps (items 2 and 3)

1 - lampa kierunkowskazów, 2 - lampa przeciwmgłowa, 3 - reflektor, 4 - lampy błyskowe, 5 - śruba mocowania reflektora. 6 - nakrętka, 7 - zderzak przedni samochodu,
a - odległość krawędzi szyby reflektora przeciwmgłowego od elementu otycznego refelktorów świateł drogowych (poz. 2 oraz 3)

7.4.2 Vehicle exterior lamps

In fire-fighting vehicles (A15 and A151) two halogen front fog lamps with yellow light are additionally used, mounted on the front bumper (Fig. 7.41). They illuminate the road in difficult weather conditions.



1.2. the headlamp's electric conductors. 3 - mounting bracket. 4 - rubber bushing, 5 - housing, 6 - H3 halogen bulb (55 W). 7 - glare from glass

1.2 - przewody elektryczne reflektora. 3 - uchwyt mocujący. 4 - przelotka gumowa, 5 - obudowa, 6 - żarówka halogenowa H3 (55 W). 7 - odblask z szyba

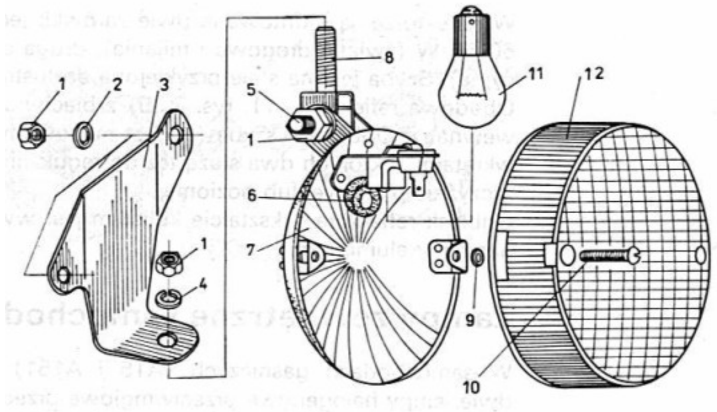
7.42. Figure: FOG LAMP CONSTRUCTION

■ The fog lamp (Figure 7.42) consists of a housing (5) made of sheet steel, a reflector Ø 140 mm with glass (7), a steel frame and a mounting bracket (3). The lamp shall use a halogen (6) H3 halogen filament lamp (55 W). These lamps are powered by a black wire through a switch on the dashboard, relay and 8 A fuse. They are activated by a key switch on the dashboard.

The rear fog lamp is shown in Figure 7.43. It is similar to a front lamp but has red light.

1 - nut M8, 2 - washer, 3 - lamp support, 4 - spring support, 5 - screw M8x30. 6 - rubber bushing, 7 - lamp reflector. 8 screw M8x30,9 rubber washer, 10 screw M4x24. 11 bulb (21 W). 12 - lamp diffuser red

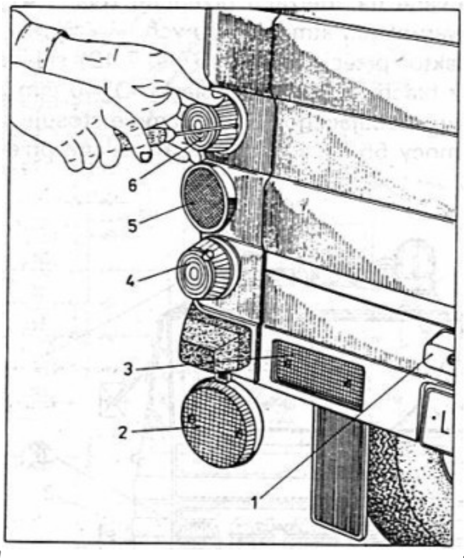
1 - nakrętka M8, 2 - podkladka, 3 - wspornik lampy, 4 - podkladka sprężysta, 5 - śruba M8x30. 6 - przelotka gumowa, 7 - odbłyśnik lampy. 8 - śruba M8x30,9 - podkładka gumowa, 10 - wkret M4x 24. 11 - żarówka (21 W). 12 - klosz lampy czerwony



7.43. Figure: REAR FOG LAMP

1 - license plate lamp. 2 - rear fog lamp (red). 3 - reversing lamp, 4 - position and braking lamp lamps, stop'. 5 - reflectors, 6 - direction-indicator lamp, 6 - direction-indicator lamps

1 - lampa oświetlenia tablicy rejestracyjnej. 2 - lampa światla przeciwmglowego tylnego (czerwona). 3 - lampa światła cofania, 4 - lampy świateł pozycyjnych i hamowania ,stop". 5 - światla odblaskowe, 6 - lampa światel kierunkowskazów



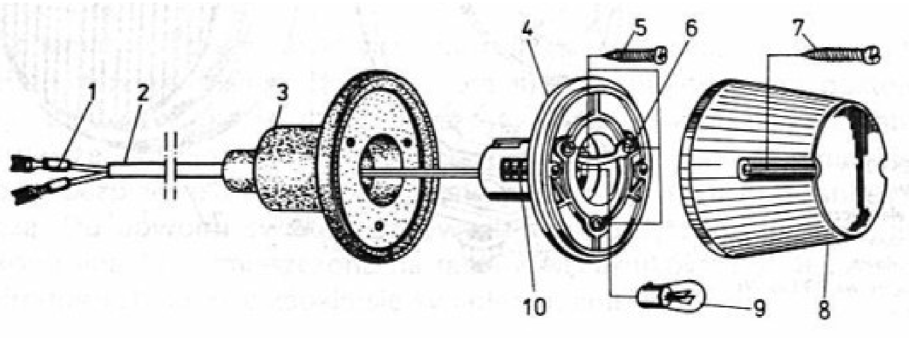
7.44. Figure: REAR LIGHTS OF VANS TYPE VEHICLES

7.4.2 Vehicle exterior lamps

■ Brake, direction indicator, rear position, fog, reversing and retro-reflectors lamps for vans are shown in Figure 7.44.

Brake lamp lamps (Fig. 7.45) light up when the foot on the brake pedal is depressed. This lamp consists of a plastic body (4) with bulb socket, a rubber casing (3), a red lens (8) made of plastic and a filament lamp (9) and cables (1).

The brake and rear position lamps shall be located in a single lamp with a filament lamp (9) with an output of 21/5 W and a filament lamp (9). A 21 W fibre gives a strong brake light and a 5 W fibre with a weaker position light. Position lamp lamps also serve as parking lamps. The operation

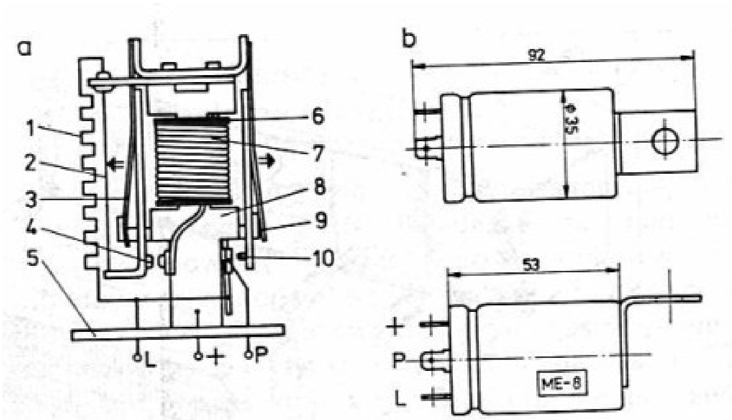


7.45. *Figure: BRAKE LIGHT LAMP (LAMPA SWIATEŁ HAMOWANIA)*

1 - lamp cable, 2 - protective tube, 3 - rubber cover, 4 - lamp body. 5 - screw for mounting the lamp, 6 - screw for connecting the lamp to the ground. 7 - a screw fixing the lens, 8 - a red lamp diffuser. 9 - stop and rear position (21/5 W) brake light bulb. 10 - frame spring bulbs

1 - przewód lampy, 2 - rurka ochronna, 3 - osłona gumowa, 4 - korpus lampy. 5 - wkręt mocowania lampy, 6 - blaszka połączenia lampy z masą. 7 - wkręt mocujący klosz, 8 - klosz lampy czerwony. 9 - żarówka światła hamowania "stop" i tylnego pozycyjnego (21/5 W).
10 - sprężyna oprawki żarówki

of the lamps is based on continuous monitoring of their operation and cleaning from dust. The most common cause of light malfunction is the burning out of a bulb or fuse that needs to be replaced.



7.46. Figure: ME-8 DIRECTION-INDICATOR INTERRUPTER (PRZERYWACZ KIERUNKOWSKAZÓW ME-8)

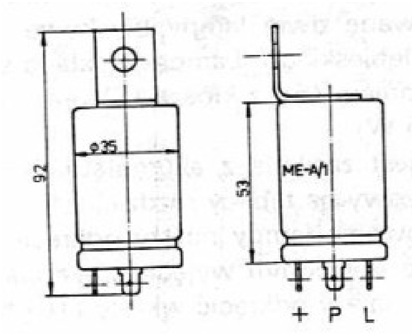
a - construction
1 - resistor, 2 - heating wire, 3.9 - plate springs, 4 - movable contact, 5 - insulation plate, 6 - insulation pad, 7 - electromagnet windings, 8 - electromagnet core, 10 - movable contact in the arrangement of direction indicator lamp control lamp.
b - scheme
L - plug-in connectors of the cable to the indicator switch, P - plug-in connectors of the cable to the control lamp. (+) - plug-in connector for powering the breaker from the battery (via the ignition switch)

a - budowa
1 - opornik, 2 - drucik grzejny, 3.9 - sprężyny płytkowe, 4 - styk roboczy ruchomy, 5 - płytka izolacyjna, 6 - podkladka izolacyjna, 7 - uzwojenia elektromagnesu, 8 - rdzeń elektromagnesu, 10 - styk ruchomy w ukladzie lampki kontrolnej kierunkowskazów
b - schemat
L - złącza wtykowe przewodu do przełącznika kierunkowskazów, P- złącza wtykowe przewodu do lampki kontrolnej. (+) - złącze wtykowe zasilania przerywacza z akumulatora (przez wylacznik zapłonu)

Front and rear direction-indicator lamps. Round direction-indicator lamps are used in vans (6, Figure 7.44). The diameter of the lamps is 82 mm. The lamp consists of a housing made of bi-plastic bi-plastic with a bulb holder and a cable with a plug socket. Different from the brake light lamp "stop". (Fig. 7.45) only because it has one wire, a single light bulb of 21 Wi yellow diffuser. Direction indicator lamps are switched on by a lever (short) on the left-hand steering column. When the lever is pressed upwards, the right hand direction indicator lamps switch on and downwards the left hand indicator lamps switch on. In these positions, the indicator light (green) on the instrument panel also illuminates with a flashing light.

7.4.2 Vehicle exterior lamps

If a fuse, light bulb or electrical circuit breaks down, the light will go out, indicating that the circuit is faulty and that the lights are off.



L, P. (+) - plug connectors

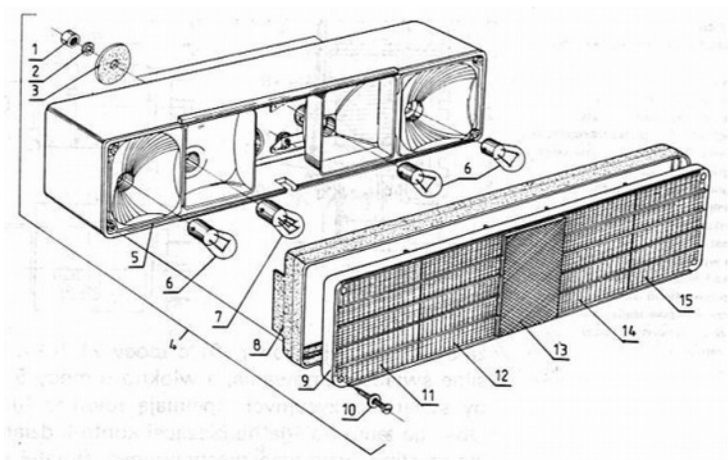
L, P. (+) - zlacza wtykowe

7.47. Figure: INTERRUPTER OF THE HAZARD WARNING SIGNAL ME-A/1 (PRZERYWACZ ŚWIATEŁ AWARYJNYCH ME-A/1)

The flashing light of the direction indicator lamps shall be obtained by placing on the circuit of these lamps a WME-8 electromagnetic interrupter lamp at a rated voltage of 12 V, 46 W (2 x 21W + 1 4W) (Figure 7.46). The interrupter is designed to operate with two 21 Watt bulbs each with a 4 W side lamp and a 2 W control lamp. At 12 V at 20 °C and 20 °C, the interrupter shall interrupt the direction-indicator lamps at 85 ± 7 cycles/min and at 10,8 V and 20 °C at 60 cycles/min. The breaker of the direction-indicator lamps and the hazard warning signal shall be mounted on the front face of the cab.

1 - nut M8. 2 - washer. 3 - rubber pad, 4 - complete left lamp, 5 - lamp body. 6 - filament lamp (21 W). 7 - filament lamp (21/5 W). 8 - diffuser gasket. 9 - lamp shade, 10 - sheet metal screw. (3,9 x 32). 11 - direction indicator light (yellow). 12 - "Stop" position and braking lamps (red), 13 - reflector, 14 - reversing lamp (white), 15 - fog lamp (red)

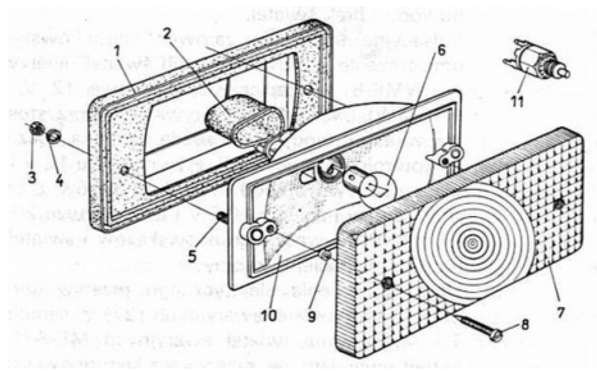
1 - nakrętka M8. 2 - podkładka. 3 - podkładka gumowa, 4 - lampa lewa kompletna, 5 - korpus lampy. 6 - żarówka (21 W). 7 - żarówka (21/5 W). 8 - uszczelka klosza. 9 - klosz lampy, 10 - wkręt do blach. (3,9 x 32). 11 - światlo kierunkowskazu runkowskazu (żółte). 12 - Światła pozycyjne i hamowania "stop" (czerwone), 13 - element odblaskowy, 14- światło cofania (białe), 15 - światło przeciwmgłowe (czerwone)



7.48. Figure: REAR COMPOSITE LAMPS OF ISOTHERMAL AND CONTAINER VEHICLES

1 - rubber boot, 2 - connector cover 3 - nut M5.4 - spring washer, 5 - screw M5, 6 - bulb (21 W), 7 - lamp shade, 8 - screw (3.9x1.9). 9 - washer, (3,9x1.9). 9 - padding. 10 - housing, 11 - reversing lamp switch (contactor)

1 - osłona gumowa, 2 - oslona złącza 3 - nakrętka M5,4 - podkładka sprężysta, 5 - śruba M5, 6 - żarówka (21 W), 7 - klosz lampy, 8 - wkręt (3,9x1,9). 9 - podkładka, (3,9x1.9). 9 - podkladka. 10 - obudowa, 11 - wyłącznik (stycznik) światła cofania



7.49. Figure: REVERSE LAMP FOR VAN-TYPE VEHICLES

7.4.2 Vehicle exterior lamps

The electrical connections between the direction-indicator breakers (33) and the hazard warning signal breaker (27) in the car are shown in Figure 7.1. The ME-A/1 hazard warning signal breaker (Figure 7.47) has the same shape and dimensions as the direction-indicator breaker, but is more powerful.

The hazard warning signal shall be switched on by a switch (p, Fig. 1.23) illuminated by an indicator light (red).

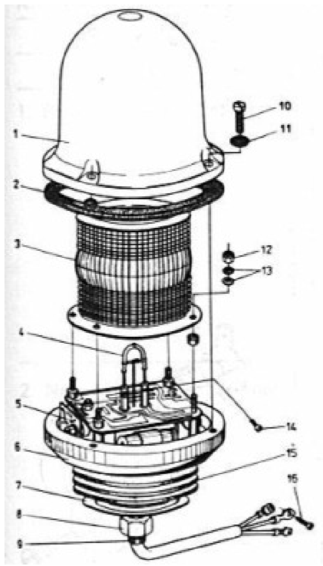
The interrupters are not repairable and must be replaced in case of damage.

In box cars A111, A161, isothermal cars A17 and containers A171, A172, etc., rear grouped lamps (Fig. 7.48) containing all the lights are used.

To replace the bulb, unscrew the four screws fixing the lamp shade, remove it and replace the bulb.

The lens of the composite lamp is glued together from the segments, so be careful not to break it when removing it.

Reversing lamp lamps are used in vans, as shown in Figure 7.49.



7.50. Figure: FLASHLIGHT (LBX-1) (LAMPY BŁYSKOWE)

1 - lamp shade. 2 - gasket. 3- lens of the lamp, 4 - tubular bulb, 5 - electronic circuit. 6 - lamp body. 7 - washer, 8 - nut (M14x1,5). 9 - Throttle screw, 10 - screw (M4x18), 11 - washer, 12 - nut, 13 - padding, 14 - screw, 15 - padding, 16 - screw (3,9x13)

1 - klosz lampy. 2 - uszczelka. 3- soczewka lampy, 4 - żarówka rurkowa, 5 - uklad elektroniczny. 6 - korpus lampy. 7 - podkładka dociskowa, 8 - nakrętka (M14x1,5). 9 - śruba dławicy, 10 - wkręt (M4x18), 11 - podkładka, 12 - nakrętka, 13 - podkladka, 14 - wkręt, 15 - podkladka, 16 - wkręt (3,9x13)

■ Flashlights (LBX-1). On the roof of the fire-fighting car cabins are mounted two electronic flashing lamps (Fig. 7.50) with a blue diffuser. This lamp consists of a body (6) with electronic interrupting (5), a lens (1) and an H3 tube halogen bulb (12 V, 55 W).

The lamp bulb is powered from the battery by a control lamp and a key switch on the dashboard. To remove the lamp, unscrew the fixing nut (8) in the cab roof (after removing the roof covering). If you need to replace the bulb, unscrew the screws (10) fixing the lens cap and remove it.

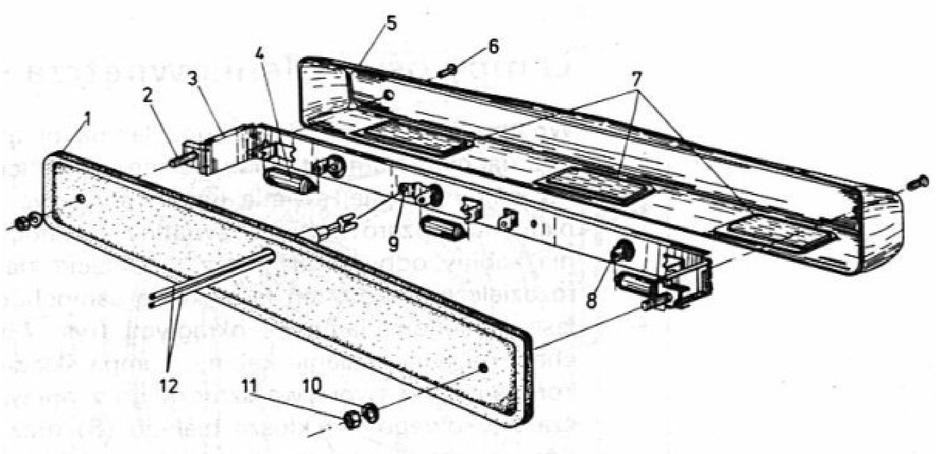
Only items 1-4, 12 and complete flash units are supplied with spare parts.

■ The rear registration plate lamp of a van is shown in Figure 7.51. It consists of a base (3), a housing (5), a rubber casing (1) and three tubular bulbs (4). There are three windows (7) in the bottom wall of the casing with plastic glasses to illuminate the license plate with the registration number. This lamp is screwed to the rear wall of the car, above the number plate, with two screws through the rubber cover (1). The registration plate lamp for container cars has a similar structure, except that it has two bulbs. Rubber cover (1) protects the inside of the lamp against the ingress of water and dust. Three tubular (5 W) bulbs are fitted in the base holders. If the bulb burns out, unscrew the two screws (6), remove the housing (5) and replace the bulb.

In isothermal A17 cars and in containers, e.g. A171 and A172, registration plate lamps as shown in Figure 7.52 are used. They are constructed similarly to those used in vans. In cars, a retro-reflecting device (red) (5, Fig. 7.44), made of plastic (Ø 075 mm), is fitted in the van.

7.4.2 Vehicle exterior lamps

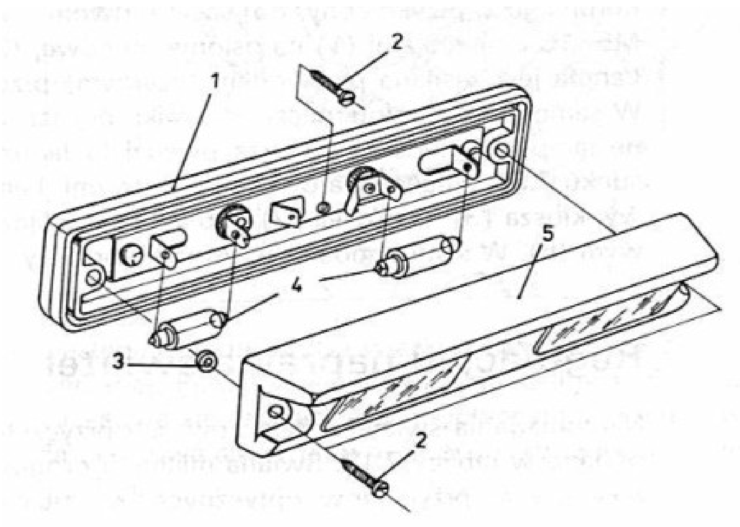
In box cars, isothermal cars and containers, reflectors are part of the lens of composite lamps and are rectangular in shape (13, Fig. 7.48). In case of damage, replace the entire lamp lens by unscrewing the four screws and replace it (with a retro-reflector).



7.51. Figure: VAN-TYPE VEHICLE NUMBER PLATE LAMP

1 - rubber cover, 2 - screw for lamp mounting, 3 - lamp body 4 - tubular bulb (5 W). 5 - lamp housing. 6 - screws (M5 x 18). 7 - quick plastic, 8 - bulb holder, 9 - plug connector, 10 - spring washer. 11 - nut (M6), 12 - electric wires

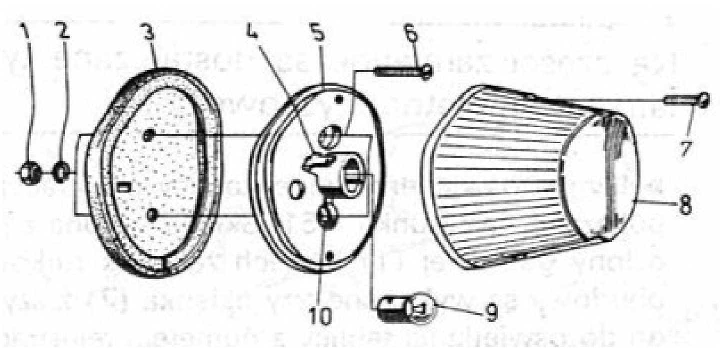
1 - oslona gumowa, 2 - śruba mocowania lampy, 3 - korpus lampy 4 - żarówka rurkowa (5 W). 5 - obudowa lampy. 6 - wkręta (M5 x 18). 7 - szybki plastykowe, 8 - uchwyt żarówki, 9 - złącze wtykowe, 10 - podkładka sprężysta. 11 - nakrętka (M6), 12 - przewody elektryczne



7.52. Figure: ISOTHERMIC AND CONTAINER CARS-TYPE VEHICULES NUMBER PLATE LAMP

1 - sheet metal screw (3.9x19). 2 - body, 3 - lens, 4 - padding, 5 - filament lamp (5 W)

1 - wkręt do blach (3,9x19). 2 - korpus, 3 - klosz, 4 - podkladka, 5 - żarówka (5 W)



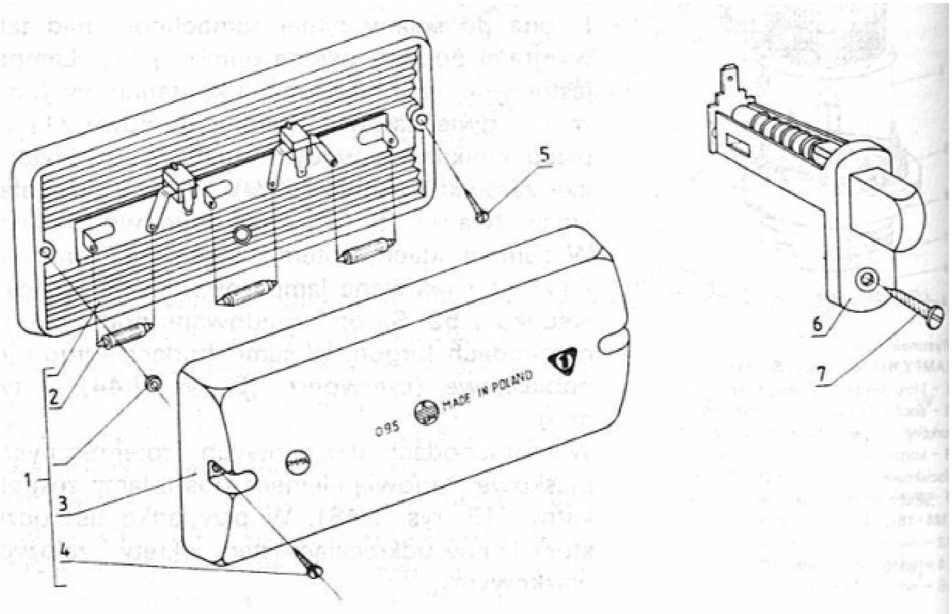
7.53. Figure: CARGO COMPARTMENT LIGHTING LAMP

1 - nut (M5). 2 - elastic pad, 3 - rubber cover. 4 - plug connectors. 5 - lamp body. 6 - fastening screw (M5x16). 7 - fastening screw (M4x14). 8 lampshade, 9 lampshade (10 W). 10 - Lamp to ground connection plate

1 - nakrętka (M5). 2 - podkladka sprężysta, 3 - osłona gumowa. 4 - zlacze wtykowe. 5 - korpus lampy. 6 - wkręt mocujący (M5x16). 7 - wkręt mocujący (M4x14). 8 - klosz lampy, 9 - żarówka (10 W). 10 - blaszka polaczenia lampy z masa

7.4.3 Vehicle interior lighting lamps

The interior of the cabin is illuminated by a round lamp located in the sheathing under the roof. This lamp has the same diameter and is similarly constructed to a round brake lamp (Fig. 7.45), different in that it has a white lens and a 10 W single light bulb. Cab lighting is switched on by pressing the switch button on the dashboard. The cargo space of van and extinguisher cars is illuminated by round lamps (Fig. 7.53) installed under a roof on the rear wall of the cabin. The lamp consists of a rubber casing (3), a plastic casing (5) with a bulb holder and a plug connector ending (4) of white lenses (8) and a 10 W filament lamp (9). The body is screwed to the wall with two M5x16 screws (6) and nuts (1) on the rubber cover (3).



1 - complete lamp, 2 - incandescent lamp (5 W). 3 - diffuser. 4 - screw (3.9x16). 5 - screw (4,8x16). 6 - light door switch, 7 - screw (3,913)

1 - lampa kompletna, 2 - żarówka (5 W). 3 - klosz. 4 - wkręt (3.9x16). 5 - wkręt (4,8x16). 6 - wyłącznik drzwiowy światła, 7 - wkręt (3,913)

7.54. Figure: INTERIOR BODY LIGHTING LAMP: MINIBUS, ISOTHERMAL AND CONTAINER BUSES

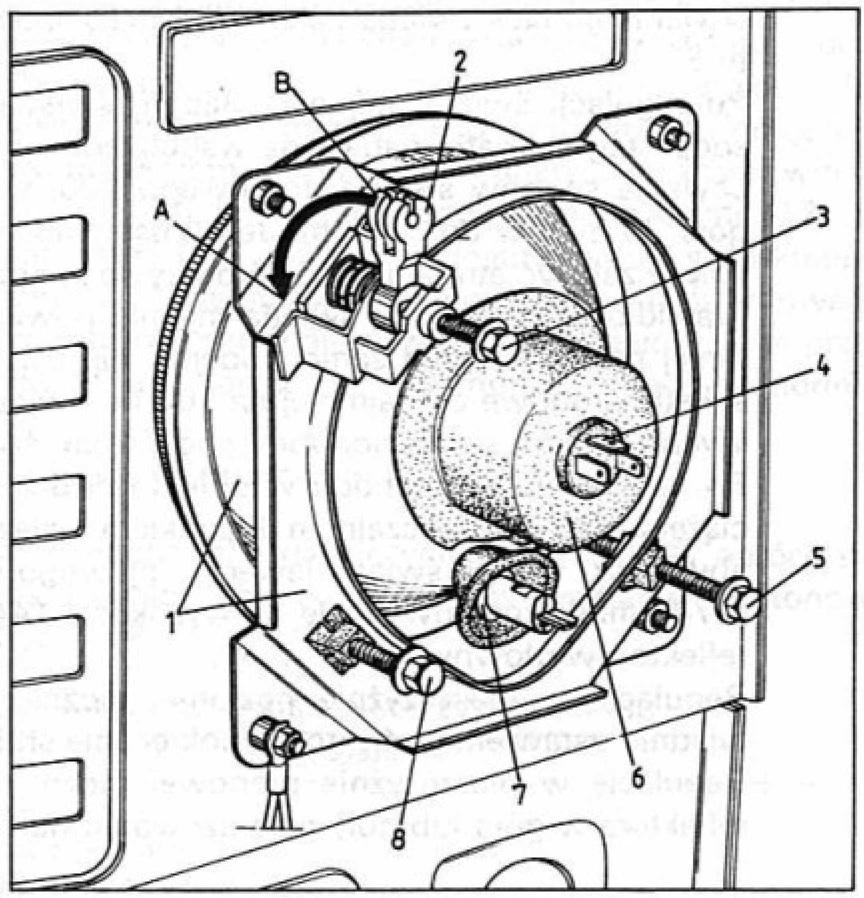
The lamp is powered by a cable (black) through a key switch. Isothermal cars, minibuses and containers use isothermal lamps for interior cargo compartment lighting, as shown in Figure 7.54, with three tubular bulbs. This lamp shall consist of a housing, a lens (3) and filament lamps (2) - 5 W. It is switched on by the door switch (6). The A17 is white on cars.

7.4.4 Adjusting and repairing lamps

Trouble	Reasons	Method of repair
1. Absence of light in the headlamp	1.1 Burnt-out bulbs.	1.1 Replace the filament lamp.
	1.2 Burnt fuse (no voltage).	1.2 Replace the fuse after the cause of the short-circuit has been removed.
	1.3 The light switch shall not apply voltage to both headlamps.	1.3 Determine the cause of the power failure in the breaker or replace the breaker.
	1.4 Corroded wire to ground or current contacts.	1.4 Check the quality of the contacts, clean them and improve connections.
	1.5 The main-beam headlamp switch shall not apply voltage to the terminals of the two headlamps.	1.5 Eliminate the cause or replace the damaged switch.
2. Incorrect road illumination	2.1. Headlamp incorrectly aligned.	2.1 Check and adjust the lamps correctly (Section 7.4.4).
	2.2 Contaminated reflector lens.	2.2. wash the reflector lens and wipe dry.
	2.3 Reflector mirrors dirty.	2.3 Wash the mirrors with distilled water by immersion and dry them with air.
	2.4 Headlamp mirrors corroded or damaged.	2.4 Replace the headlamps.

7.17. Table: HEADLIGHTS TROUBLESHOOTING

The failures of the headlamps, their causes and their means of removal are given in Table 7.17. The passing and driving lamps shall be checked and adjusted using optical instruments at the control station. These lights can be set by the user himself if he has a control screen.



1 - complete headlamp, 2 - lever for the adjustment of the lights depending on the load of the vehicle, 3 - screw for adjusting the lights in a vertical plane. 4 - bulb (60/55 W), 5 - screw for adjusting the horizontal position of the lamps. 6 - rubber bulb cover, 7 - parking lamp bulb (4 W). 8 - headlamp mounting screws
A - unladen car, B - laden car

1 - reflektor kompletny, 2 - dźwignia korektora ustawienia świątel zależnie od obciążenia samochodu, 3 - wkręt regulacji ustawienia świateł w płaszczyźnie pionowej. 4 - żarówka (60/55 W), 5 - wkręt regulacji ustawienia świateł w plaszczyźnie poziomej. 6 - osłona gumowa żarówki, 7 - żarówka świateł postojowych (4 W). 8 - śruby mocowania reflektora
A - samochód bez ładunku, B - samochód z ładunkiem

7.55. Figure: ADJUSTMENT OF VEHICLE LIGHTS

Only dipped-beam headlamps (with a laden vehicle and normal tyre pressure) are adjustable. Two headlamp screws (Fig. 7.55) are used to adjust the headlamp, accessible by lifting up the front cover of the cab and removing the air inlet grille. The screw (3) is used to adjust the light beam

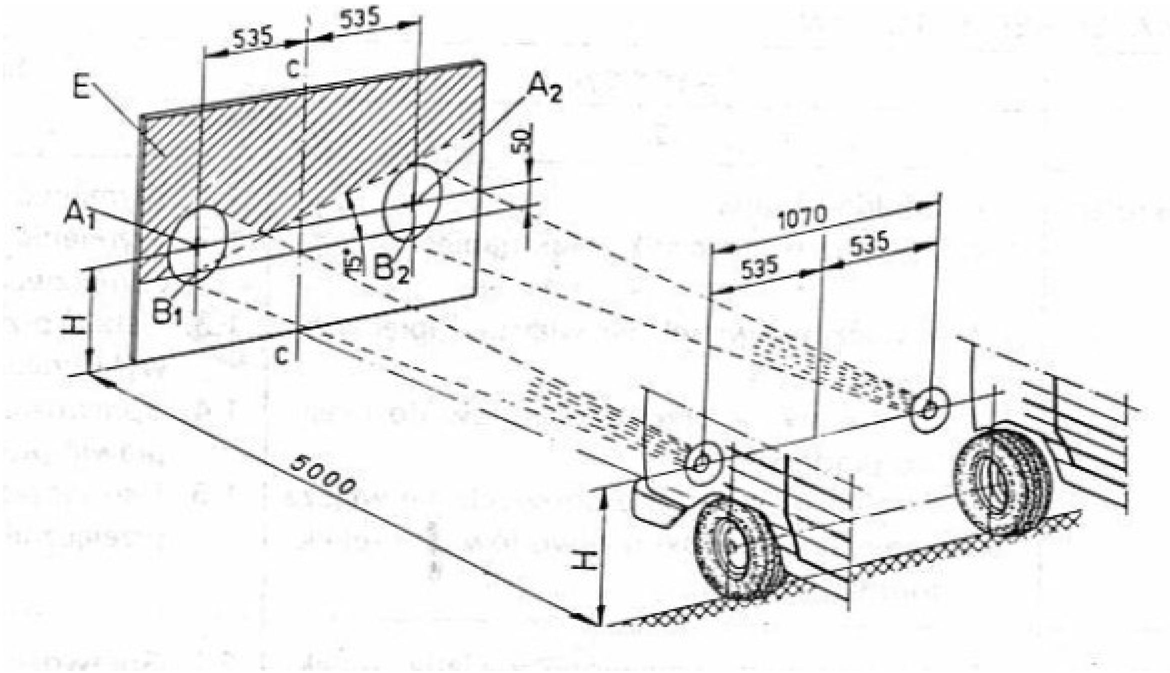
vertically and the screw (5) is used to adjust horizontally. When screwing the light beam to the right with the upper screw (3) and to the left with the upper screw (3), the light beam is raised and lowered. When turning the bottom screw (5) to the right, the light stream moves to the left and when turning the screw to the left, the light stream moves to the right. The method of setting the lamp is shown in Figure 7.56.

When starting to adjust the lights it is necessary to do so:

- position the car 5 m from the screen or white wall and load it according to Table 1-2;
- check that the tyre pressure corresponds to the required values and measure the height from the centre of the reflector to the ground; the distance between the centres of the headlamps is constant (1070 mm) and the height depends on the vehicle load;
- determine the measured coordinates of headlamps A_1 and A_2 on the screen or wall and check the alignment of the dipped-beam headlamp beam relative to the coordinates of these points;
- turn on the dipped-beam headlamps, cover the right headlamp and set the left with the screws (3) and (5) so that the cut-off line passing through coordinates A_1 and A_2 on the screen is at an angle of 15° to the left starting at point B_1.

A_1, A_2 - coordinates of the axis of position of the headlamps, B_1, B_2 - coordinates of the axis of the headlamps after setting the dipped-beam headlamps, E - control screen, H - height of the axis of the headlamps above the ground of the fully laden vehicle

A_1, A_2 - współrzędne osi rozmieszczenia reflektorów, B_1, B_2 - współrzędne osi reflektorów po ustawieniu świateł mijania, E - ekran kontrolny, H - wysokość osi reflektorów od podłoża samochodu obciążonego pełnym ładunkiem



7.56. Figure: ADJUSTMENT OF THE VEHICLE HEADLAMPS

Adjust the headlamp on the right in the same way, with an angle of 15° between the cut-off and the right-hand headlamp from point B_2.

After adjusting the dipped-beam headlamp, switch on the main-beam headlamp and check that the beams of the main-beam headlamp fall within coordinates A1, and A2. 100 mm to the right or left, upwards 75 mm, downwards 50 mm is permissible.

Correctly set dipped-beam headlamps should illuminate the road at least 40 m in front of the vehicle and not dazzle road users and the main-beam headlamps at least 100 m apart. The headlamps of fog lamps shall be adjusted in a similar way as the headlamps. Once the vehicle is positioned 5 m from the screen or wall and loaded with the permissible load, adjust the headlamps

so that the centre of the left and right headlight beams (740 mm apart) are 144...150 mm below the centre of the headlamps.

Horizontal adjustment can be carried out by adjusting the headlamp accordingly and tightening the M6 mounting screw.

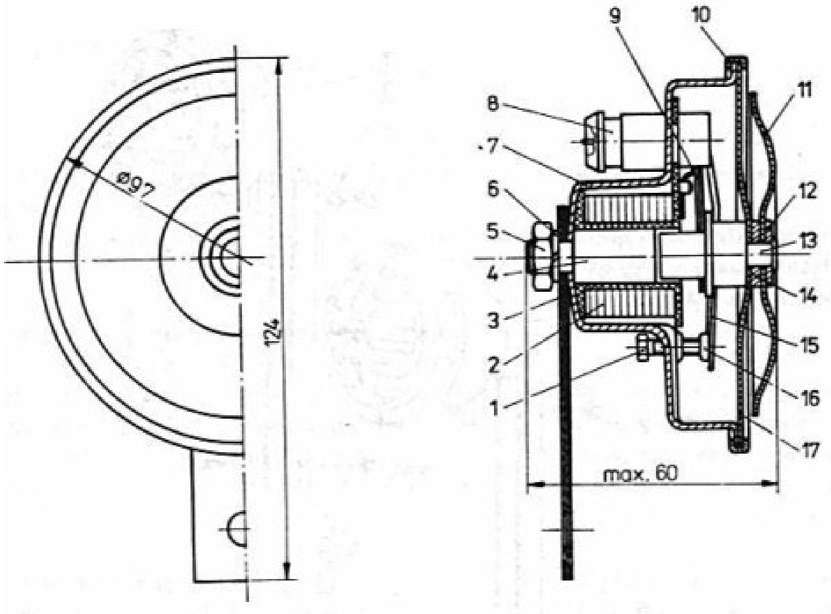
The adjustment in the vertical plane may be made (by tilting the reflector up or down) after unscrewing the nut (5, Figure 7.49).

7.5 ELECTRICAL APPLIANCES

The vehicle's electrical equipment includes a sound signal, wipers, windscreen washer and a kilometre counter speedometer.

7.5.1 Vehicle horns

Horn (normal)



1 - adjusting screw, 2 - electromagnet, 3 - signal support, 4 - core, 5 - nut M8, 6 - spring washer, 7 - housing. 8 - plug connector. 9 - spring, 10 - ring, 11 - resonator, 12, 14 - washers, 13 - anchor, 15 - bridge, 16 - insulation pad, 17 - membrane

1 - wkręt regulacyjny, 2 - elektromagnes, 3 - wspornik sygnału, 4 - rdzeń, 5 - nakrętka M8, 6 - podkładka sprężysta, 7 - obudowa. 8 - złącze wtykowe. 9 - sprężyna, 10 - pierścień, 11 - rezonator, 12, 14 - podkładki, 13 - kotwica, 15 - mostek, 16 - wkladka izolacyjna, 17 - membrana

7.57. Figure: SYGNAŁ DZWIĘKOWY (HORN)

The audible signal (Fig. 7.57, Tables 7-18) consists of a housing (7) made of sheet steel, an electromagnet (2) with an interrupter, a steel diaphragm (17) with an anchor, a disc resonator (11) and a ring (10) with sheet steel.

The sound signal is attached to the bracket (3) at the left headlamp. It is connected to the power source (battery) by a lever switch on the steering column. The signal is activated by pressing the lever (on the right hand side of the steering wheel) upwards. The membrane vibrates the air in a suitably shaped resonator and emits sound waves into the environment.

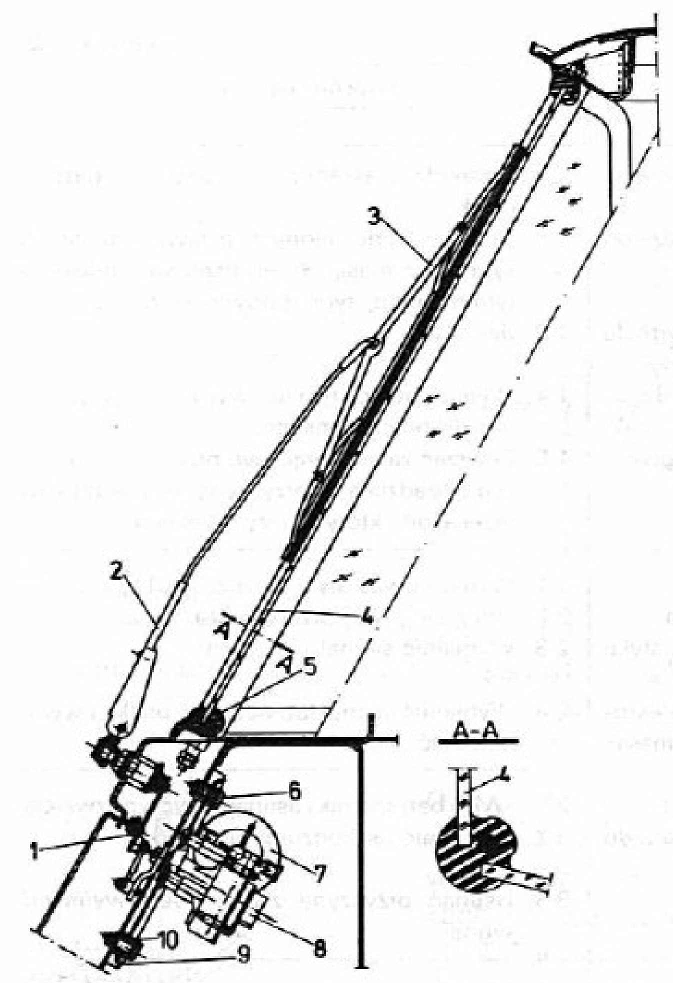
The solenoid winding circuit can be checked by serial connection of a 40 W light bulb and connection to a power source (battery). The magnetic gap, the size of which determines the tone height, can be adjusted with washers (12, 14) seated under the membrane (17). The signal tone is adjusted by means of the screw (1). The signal should be considered properly adjusted (installed in the car) when the sound level is 90 dB at a distance of 7 m in front of the car. These measurements are performed in accordance with PN-83/S-76004 standard.

Two-tone horn – todo

7.5.2 Glass wiper system

The windscreen wiper system for the cab (Fig. 7.60) consists of an electric motor with dent drive (7), a lever assembly with cranks (1) and wiper arms (2) and blades. The wiper switch is located on the right hand steering column. The wiper motor (Fig. 7.61) has a built-in serial bypass winding (14) with brake coil and 12 V supply voltage. A bypass coil is fitted at one of the poles.

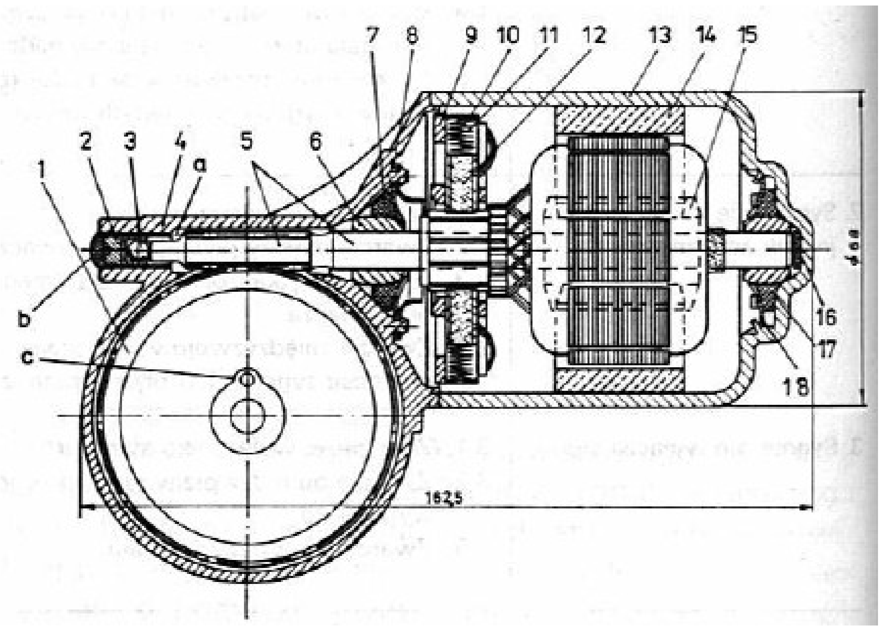
7.5.2 Glass wiper system



1 - notched lever, 2 - wiper arm, 3 - wiper blade, 4 - windscreen, 5 - glass gasket, 6 - engine fixing screw, 7 - wiper motor with transmission, 8 - plug connector. 9 - motor memory, 10 - rubber pad

1 - dźwignia z karbami, 2 - ramię wycieraka, 3 - pióro wycieraka, 4 - szyba przednia samochodu, 5 - uszczelka szyby, 6 - Śruba mocująca silnik, 7 - silnik wycieraczki z przekładnią, 8 - złącze wtykowe. 9 - wspomnik silnika, 10 - podkladka gumowa

7.60 Figure: WINDSCREEN WIPER (WYCIERACZKA SZYBY)



7.61 Figure: WIPER MOTOR (SILNIK NAPĘDU WYCIERACZKI)

1 - gear wheel, 2 - adjusting screw, 3 - pressure ball, 4 - gear housing, 5 - worm armature, 6 - plain bearing, 7. 17 - sealing, 8. 18 - bed compression spring, 9 - brush holder. 10 - spring, 11 - brush spring, 12 - graphite brush, 13 - motor body, 14 - excitation winding (stator), 15 - magnet pressure spring

1 - koło zębate przekładni, 2 - wkręt regulacyjny, 3 - kulka dociskowa, 4 - obudowa przekładni, 5 - twornik ze ślimakiem, 6 - łożysko ślizgowe, 7. 17 - uszczelnienie, 8. 18 - sprężyna dociskowa łożyska, 9 - szczotkotrzymacz. 10 - sprężyna, 11 - sprężyna szczotki, 12 - szczotka grafitowa, 13 - korpus silnika, 14 - uzwojenie wzbudzenia (stojan), 15 - sprężyna dociskowa magnes

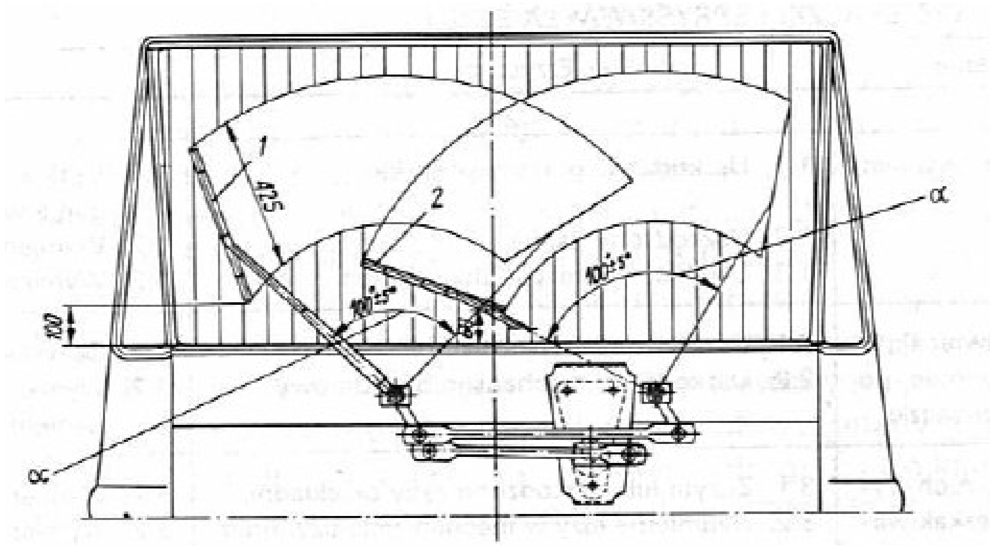
The motor consists of a metal housing (13), a rotor (5), a bypass coil, a series coil and a brake coil (14), a pole and a gearbox (1 and 5) with an output shaft. The motor body consists of two parts, the

front cover being at the same time the gearbox housing. The gearbox channels (a, Fig. 7.61) are filled with grease. The gear unit housing has a cam operated limit switch on the worm gear which is connected in parallel with the switch on the indicator board on the motor power circuit.

The wiper shafts for mounting the arms are ended with a cone with a fine groove. The wiper arms (2, Fig. 7.60) are seated on the drive shaft pivots and secured with a flat spring. The wiper blades (3), 425 mm long, are pressed against the glass by springs mounted on the lower part of the wiper arm (2). These springs are fixed in the arms with a preload so that the tension of the windscreen wiper on the measured windscreen wiper pressure, measured perpendicularly to the windscreen, is equal: 2,4...5 N.

Wiper type	121.000
Motor voltage and rated power	12 V, 36 W
Rated torque	approx. 1,6 N·m
Torque with braked engine	approx. 9 N·m
Current consumption (at idling speed and at 12 V voltage)	max. 3,0 A
Engine speed (rated)	3000 rpm
Wiper pressure on glass	2,4…5 N
Wiper angle (on wet glass)	100° ± 5°
Number of wiper blades per minute	approx. 50

7.21 Table: TECHNICAL CHARACTERISTICS OF THE WIPER SYSTEM



1,2 - wipers, α - angle of operation of wipers on wet glass

1,2 - wycieraki, α - kąt pracy wycieraków na mokrej szybie

7.62 Figure: WINDSCREEN WIPING FIELD

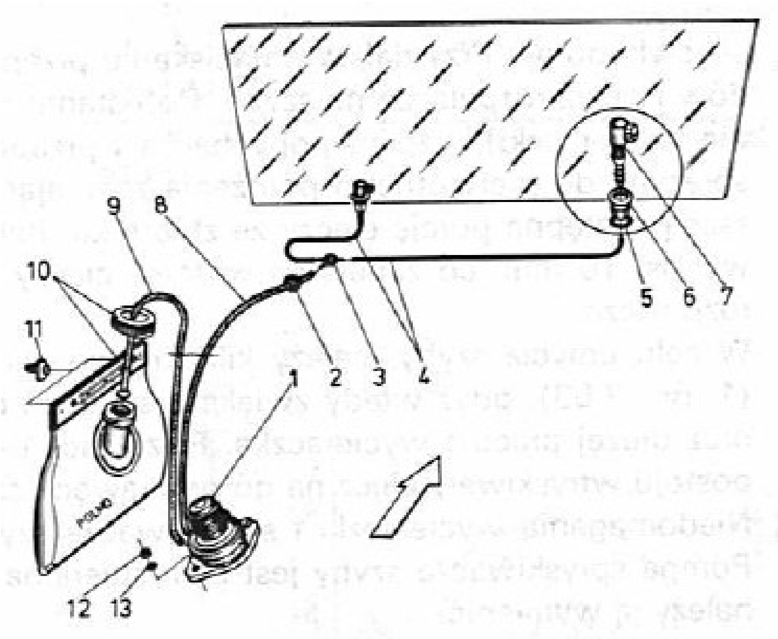
The connection of the arm to the mounting head is articulated, allowing the wiper arm to swing 90° away from the glass. This makes it easy to remove the wiper arms and clean the glass. The rubber of the wiper blades should move freely in the handles.

The wiper arms should be mounted on the multi groove of the drive shafts in such a way that the wipers, in their extreme positions, do not extend beyond the glass frame and the wiping field corresponds to the field shown in Fig. 7.62.

When the wiper switch is in the off position, the brake coil consisting of a small number of large cross-section coils is activated, the limit switch opens and the wiper motor stops. The limit switch is

designed in such a way that the wipers always return (automatically) to their original position when the wiper system is switched off.

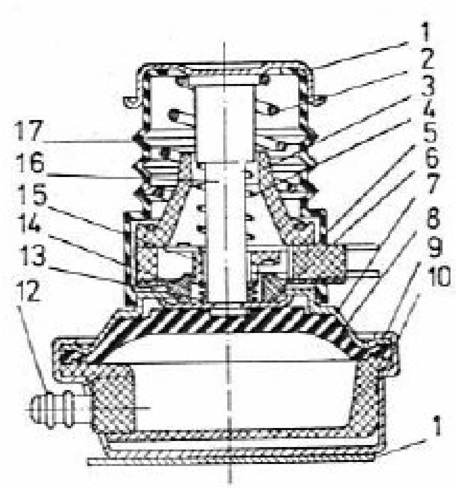
The wiper system shall operate at one speed and shall operate at a rate of 50 wavelengths per minute.



1 - washer foot pump, 2 - rubber bushing, 3 - tees, 4,8,9 - hoses, 5 - ring, 6 - insert, 7 - water sprayer, 10 - flexible water tank (2 dm), 11 - hooks for tank mounting, 12 - nut, 13 - washer.

1 - pompa nożna spryskiwacza, 2 - przelotka gumowa, 3 - trójnik, 4,8,9 - przewody elastyczne, 5 - pierścień, 6 - wkladka, 7 - rozpylacz wody, 10 - zbiornik elastyczny wody (2 dm), 11 - haczyki mocowania zbiornika, 12 - nakrętka, 13 - podkładka

7.63 Figure: WINDSCREEN WASHER SYSTEM (SPRYSKIWACZ SZYBY)



7.64 Figure: WINDSCREEN WASHER FOOT PUMP (POMPA NOŻNA SPRYSKIWACZA SZYBY)

1 - the pump casing, 2 - 4.13 - the springs. 3 - guide, 5 - insert, 6 - interrupter and diaphragm cover, 8 - diaphragm, 9 - housing. 10 - body, 11 - base, 12 - valve connections, 14 - guide plate for movable contacts, 15 - insert for movable contacts, 16 - pin, 17 - rubber cover.

1 - osłona pompy, 2. 4.13 - sprężyny. 3 - prowadnik, 5 - wkladka, 6 - osłona przerywacza i membrany, 8 - membrana, 9 - obudowa. 10 - korpus, 11 - podstawa, 12 - króćce z zaworami, 14 - płytka prowadząca styki ruchome, 15 - wkladka ze stykami ruchomymi, 16 - sworzeń, 17 - osłona gumowa

■ The windscreen washer system (Figure 7.63) consists of a container (10) located on a front baffle inside the cab, flexible hoses, tees (3), foot pumps (1) and nozzles (7).

The tank (2 dm3) is made of a flexible film with an inlet and a lockable stopper.

The pump (Fig. 7.64), which is mounted on the floor of the cab within reach of the driver's left leg, consists of a tank and a diaphragm and a discharge pin. After pressing the foot on the pump, the

wiper is switched on and in case of jump 1... ...3 mm, the insert (15) is moved to open the lower contacts. During further pressing, the diaphragm presses the liquid into the pipes and through the nozzles onto the glass. When the pressure on the pump stops (wiper off), the tappet pin and the diaphragm return to their original position under the action of a spring, suctioning the next portion of liquid from the tank through the hose and suction nozzle. The full stroke of the pump tappet is 10 mm, providing a 1,5 cm spray rate per nozzle.

In order to wash the glass, press the pump button several times with your foot (1, Fig. 7.63), as this increases the amount of liquid that is pressed on the glass and the wiper system operates longer. The nozzle shall be set so that it injects liquid at the upper edge of the windscreen when the vehicle is stationary.

The failure of the windscreen wiper and washer system is indicated in Table 7-22, the windscreen washer pump is indelible and must be replaced in the event of damage.

Trouble	Reasons	Method of repair
1. Insufficient windscreen wiping	1.1 Wiper rubber defective.	1.1 Replace the damaged wiper with a new one.
	1.2 Damaged batten.	1.2 Replace the moulding
	1.3 Weakened compression spring.	1.3 Replace the spring.
2. The wipers do not return to their original position when the wiper is switched off.	2.1. Limit switch defective.	2.1 Clean the contact or replace the switch.
	2.2 Damaged lever mechanism.	2.2 Replace or repair the defective component.
3. Uneven wiper movement (skipping)	3.1 Worn or damaged gear teeth.	3.1 Replace the gear wheel.
	3.2 Excessive play in the lever mechanism.	3.2 Replace the crank and lever bushings or replace the complete system.
4. Wiper arm not driven	4.1 Damaged lever mechanism.	4.1 Remove the system and repair or replace it.
	4.2 A broken power supply circuit.	4.2 Find a break and remove it or replace the fuse.
	4.3 Wiper switch defective.	4.3 Replace the Switch.
	4.4 Damage to engine interiors.	4.4 Remove the motor and check the winding, replace damaged motor.
5. The wiper does not work when the pump is under pressure.	5.1 Pump switch defective.	5.1 Check the operation of the wiper with the lever on the steering column.
	5.2 Clean the clamp, replace defective pump.	5.2. four-wire terminal damaged.
6. Liquid discharges too low or in small quantities	6.1 Incorrectly positioned nozzles or contaminated nozzle openings.	6.1 Position the nozzles correctly or clean their openings.
7. Liquid discharges in small quantities or not at all	7.1 No liquid in the tank.	7.1 Pour the liquid into the spray liquid tank
	7.2. dirty hose nozzle net.	7.2 Clean the net.
	7.3 System leakage.	7.3 Remove any leaks.

7.22 Table: WINDSCREEN WIPER AND WASHER SYSTEM TROUBLESHOOTING

7.5.3 Speedometer and odometer

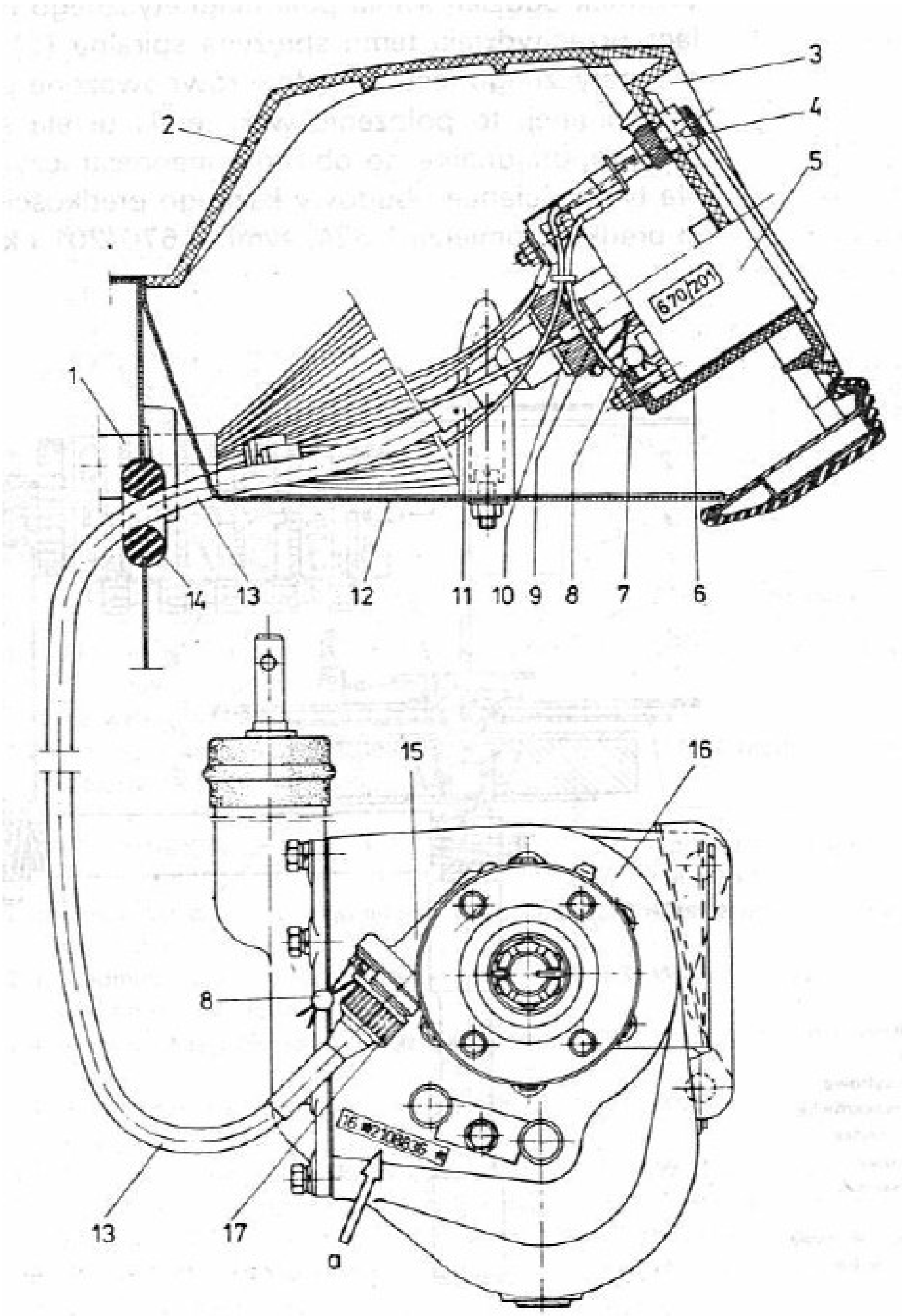
The speedometer type 670/201 is a magnetic device with a kilometre drum meter.

The drive mechanism for the speedometer (Fig. 7.65) consists of a 5:18 gearbox (15) with a flexible drive shaft (13) and a speedometer (5) in the rear cover of the gearbox.

The flexible drive shaft (13) according to BN-68/3686-01 consists of a steel cable, placed in a flexible pancerzų, rolled up of steel wire, at the end of which the crimped ends are fitted with round nuts.

7.5.3 Speedometer and odometer

The drive cable (on shaft 13), symbol 4L, is 234±1 mm long and has a diameter of 3,3 mm. It consists of layers of bolted steel wires on a steel core with a diameter of 0,35 mm. The two inner layers are made of Ø 0,3 mm wire and the two outer layers are made of Ø 0,45 mm wire. The wire layers are crosswound in relation to each other. The cable ends, 35 mm and 22 mm long, have a square cross-section fitting. The armouring of the flexible shaft, having an inner diameter of 4,9 mm, an outer diameter of 8 mm and a length of 2255 ± 3 mm, shall be made of two steel wires (one round and the other triangular). At both ends of the line there are flanged ends.



1 - main wiring harness. 2 - dashboard housing, 3 - dashboard cover, 4 - indicator light. 5 - car speedometer 670/201, 6 - car speedometer insert. 7 - nut, 8 - seal, 9 - scale lighting lamp, 10 - drive shaft nut. 11 for the end of the fight, 12 for the dashboard shelf. 13 - drive flexible shaft complete. 14 - rubber bushing, 15 - speedometer transmission, 16 - gearbox, 17 - roller nut, a - gearbox number

1 - wiązka przewodów główna. 2 - obudowa tablicy rozdzielczej, 3 - pokrywa obudowy, 4 - lampka kontrolna kierunkowskazów. 5 - prędkościomierz samochodu 670/201, 6 - wkładka licznika. 7 - nakrętka, 8 - plomba, 9 - lampka oświetlenia skali, 10 - nakrętka walka napędowego. 11 - końcówka walka, 12 - półka tablicy rozdzielczej. 13 - wałek giętki napędu kompletny. 14 - przelotka gumowa, 15 - przekladnia napędu szybkościomierza, 16 - skrzynka biegów, 17 - nakrętka walka, a - numer skrzyni biegów

Figure 7.65: SPEEDOMETER DRIVE (NAPĘD PRĘDKOŚCIOMIERZA)

In order to achieve tightness on the armour, the cover is made of synthetic resin resistant to gasoline and grease. One end of the line is seated in the square hole of the drive shaft of the gearbox

speedometer by means of a resistance flange and a nut, and the other end is seated in the square hole of the drive shaft of the speedometer magnet (Fig. 7.65). The bending radii of the flexible shaft shall be greater than 180 mm. On the circumference of both flexible shaft nuts there is an ear, with a hole, for putting seals (on the counter at the gearbox).

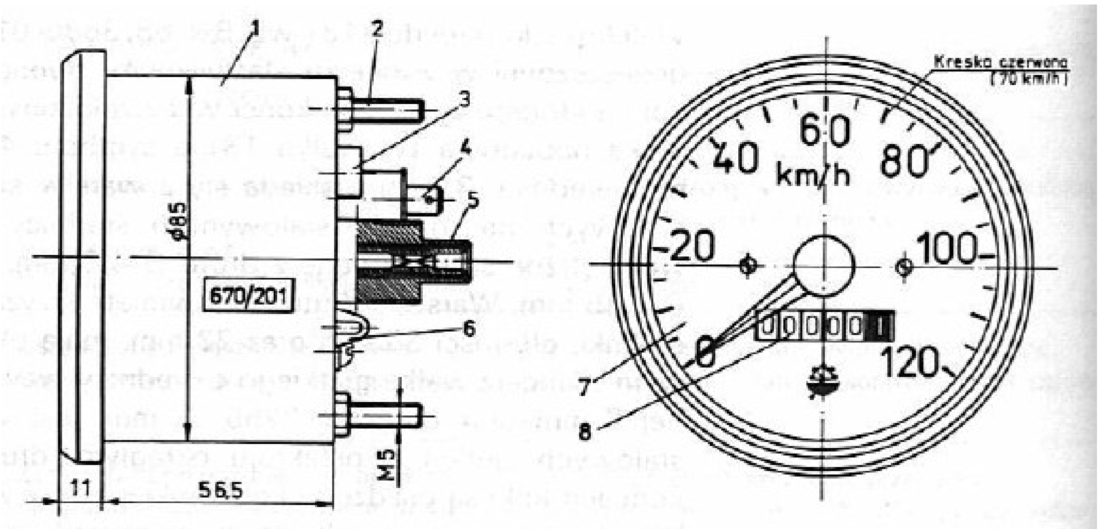


Figure 7.66: SPEEDOMETER WITH ODOMETER (670/201) (PRĘDKOŚCIOMIERZ Z LICZNIKIEM KILOMETRÓW)

1 - housing, 2 - screw, 3 - seal of legalization feature. 4 - bulb with bulb holder, 5 - drive end for speedometer, 6 - wire eye for seal. 7 - speedometer, 8 - odometer

1 - obudowa, 2 - śruba, 3 - plomba cechy legalizacyjnej. 4 - żarówka z oprawką, 5 - końcówka napędu prędkościomierza, 6 - ucho na drut plomby. 7 - prędkościomierz, 8 - licznik kilometrów

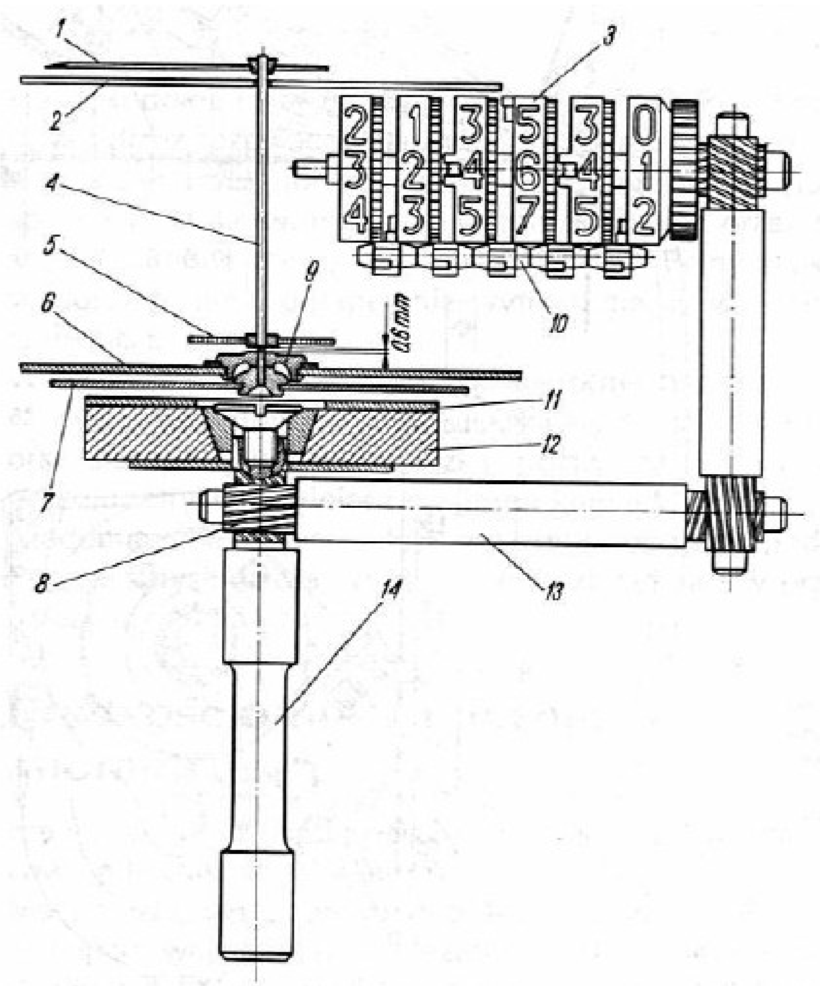


Figure 7.67: SPEEDOMETER AND ODOMETER MECHANISM

1 - pointer, 2 - digital disc, 3 - counter assembly, 4 - pointer axis, 5 - return spring, 6 - carrier plate, 7 - aluminium drum. 8 - Screw, 9 - bushing, 10 - sprocket wheel, 11 - compensator, 12 - permanent magnet, 13 - transmission shaft, 14 - speedometer shaft

1 - wskazówka, 2 - tarcza cyfrowa, 3 - zespół liczydel, 4 - oś wskazówki, 5 - sprężyna powrotna, 6 - płytka nośna, 7 - bębenek aluminiowy. 8 - ślimak, 9 - tulejka łożyskowa, 10 - kółko przerzutowe, 11 - kompensator, 12 - magnes trwały, 13 - walek przekładni, 14 - wałek prędkościomierza

7.5.3 Speedometer and odometer

■ The speedometer (Fig. 7.66) consists of a housing (1) containing the speed measurement mechanisms and a kilo ohmeter counter mechanism. In the body (Fig. 7.67), cast in zinc alloy, the speedometer shaft (14) is fitted with a screwed-on permanent magnet plate (12). The magnet disk (12) is driven by a flexible shaft. The pointer and drum are held in position at the beginning of the speedometer disc scale by a spiral spring.

As a result of the magnetic field action, the cylinder tries to rotate, but is counteracted by a spiral spring (5). If the magnetic field action is exactly balanced by the spring action. The position of the pointer is determined by the spiral position indicator. The deviation of the pointer is proportional to the rotation of the magnet, i.e. to the speed of the car. The housing of each speedometer is marked on the rear panel with a fixed speed indicator 1:624, the symbol 670/201 and the serial number.

Typ	670/201
Translation	624 : 1
Scope of indication	0...120 km/h
Accuracy of indications	-1 km/h… + 3 km/h
Bulbs for scale lighting	12 V, 2 W
Diameter	85 x 96 mm
Length	97,0 mm
Housing	made of plastic
Requirements and tests	according to EN-72/S-95020
Red dash on the disc.	at 70 km/h
Drive end	according to PN-75/S-95010

7.23 Table: SPEEDOMETER CHARACTERISTICS

■ The mechanism for measuring the distance travelled (the counting unit) is driven by a shaft with a worm (14) through two shafts (13), with a worm gearing and an internal gear ratio of 1:624, means it makes 624 rotations per each kilometre of the distance travelled by the rollers (14) of the magnet. The wheels of the digital counters, which determine the metres and kilometres (up to 99999,9 km), are rotated by means of the wheels (10). The kilometre counter has 6 digital wheels and can show a maximum car mileage of up to 99999.9 km, after which it will start counting the kilometre from the beginning. The speedometer housing is equipped with 2 Watt incandescent lamp holders for scale illumination. The maximum speedometer error is +4%. The speedometer is subject to periodic verification by the Office of Measures and Weights (PN-72/S-95020).

The failures of the speedometer are presented in Table 7-24.

The flexible shaft rope is lubricated during assembly with machine grease no. 2 (according to PN-68/C-96130) which does not thicken at low temperatures (approx. 1.5 g per meter of shaft length) and does not require lubrication during operation. If the cable breaks, replace the entire Original CD with a new one. When installing the PTO shaft, ensure that the cable end is seated in the counter shaft with a clearance of 1...3 mm and that the bending radii of the PTO shaft are more than 180 mm.

In case of increased resistance of the speedometer drive units, the cooperating elements can be lubricated with e.g. WZ/wg oil (PN-74/C-96072) or engine oil.

The speedometer, whose pointer vibrates within large limits, must be repaired or replaced. When replacing the speedometer or the flexible drive unit, the units shall be resealed. This should be done

in the ASO and recorded in the warranty booklet of the (new) vehicle. Repairs of the speedometer are performed by specialist plants authorized by the Office of Measures and Weights.

Trouble	Reasons	Method of repair
1. Lack of drive for the speedometer	1.1. broken meter drive cable due to too small a bending radius or jammed magnet bout.	1.1 Check the cable and replace it if necessary.
	1.2 Excessive axial clearance in worm gear units.	1.2 Return the speedometer for repair.
2. Excessive vibration of the pointer while driving	2.1 Too sharp a kink in the speedometer drive shaft.	2.1 Check the position of the PTO shaft and correct it if necessary.
	2.2 Insufficient lubrication of the cable in the shaft shell.	2.2 Lubricate or replace the roller with a new one.
	2.3 Excessive axial and radial play of the pointer axis in the bearing.	2.3, 2.4, 3.1, 3.2 Replace the meter.
	2.4. spring break or loose.	
3. Incorrect display of kilometres travelled	3.1 Excessive axial clearance in worm gear.	
	3.2 Excessive axial play of the digital wheels.	
	3.3. Incorrect tyre pressure.	3.3 Adjust the tyre pressure to the recommended values.
	3.4 Incorrect tyre size.	3.4 Replace tyres with the correct ones.

7.24 Table: SPEEDOMETER TROUBLESHOOTING

7.6 ELECTRICAL INSTALLATION

The car has a single-wire electrical installation whose negative pole (-) is connected to ground. The electrical installation includes bundles and single wires, a set of indicators, switches, relays, a set of fuses to protect individual electrical circuits and a portable lamp socket. Therefore, when mounting the receivers in a car, care should be taken to ensure that their housings have a proper electrical contact (pure metallic) and that the voltage drop in their circuits is as low as possible.

7.6.1 Electrical cables

The battery is connected to the starter with a copper wire, one-core (round) with a cross-section of 3,5 mm^2, and with the car ground with a copper wire, tape wire (braided) with a cross-section of 17 mm^2 (Fig. 7.1). The engine, frame and bodywork (strap) mass cables shall be 2,5 mm^2 in diameter.

The wires of the electrical installation (type LgY-S) are made of copper cable with a cross-section of 1, 1, 5 and 2,5 mm^2.

The individual wires in the bundles are connected by plug connectors. This connection makes it much easier to assemble cables and repair the installation. The cable cross-sections are selected in such a way that after switching on the receivers there are no excessive voltage drops or heating of the cable insulation. For this reason, all cable changes must be carried out using cables with the specified cross sections (Fig. 7.1).

In order to facilitate connection of the receivers and operation, the electrical equipment connectors and ends of the electric cables are numbered (according to BN-69/3680-01) and the wires are insulated in different colours. The cables are grouped in electrical bundles and wrapped in polyvinyl tape. The strap shall be so tight as to prevent longitudinal movement of the straps when a force of 30 N is applied.

The cables are assembled with a certain reserve of length, so that they are not stretched when the cubic elements of the car are moved together. Electrical wiring harnesses, like single wires, are attached to the body by means of hooks. Cables with worn insulation should be wrapped with insulation tape or replaced with new ones.

Cables whose insulation is damaged (due to aging) must also be replaced. Check the quality of the cable connections periodically and when repairing the electrical system.

7.6.2 Fuses

The electrical system is protected against excessive current loading by 12 8A fuses and one 16A fuse, and in fire-fighting vehicles by 14 8A fuses and one 16A fuse.

These fuses are located in two boxes (fig. 7.68). Each box has two rows of brass clamps. The lower terminal row is numbered 1...10 and the upper terminal row is numbered A-L. The terminals marked 3-4, 5-6, 7-8 and 9-10 are electrically connected.

The upper and lower terminals are equipped with fuse sockets (4). The rear parts of the terminals are terminated with plug connectors (1) to connect the electrical conductors of the current-consuming appliances. The fuse box (2) is attached to the shelf of the instrument panel.

There are also ten fuses in the auxiliary box, only five of which are used to protect electrical equipment in fire-fighting vehicles and containers. The remaining fuses are spare and can be used to install additional electrical devices in the car.

A list of fuses and fuse circuit breakers is given in Table 7-25.

7.6.2 Fuses

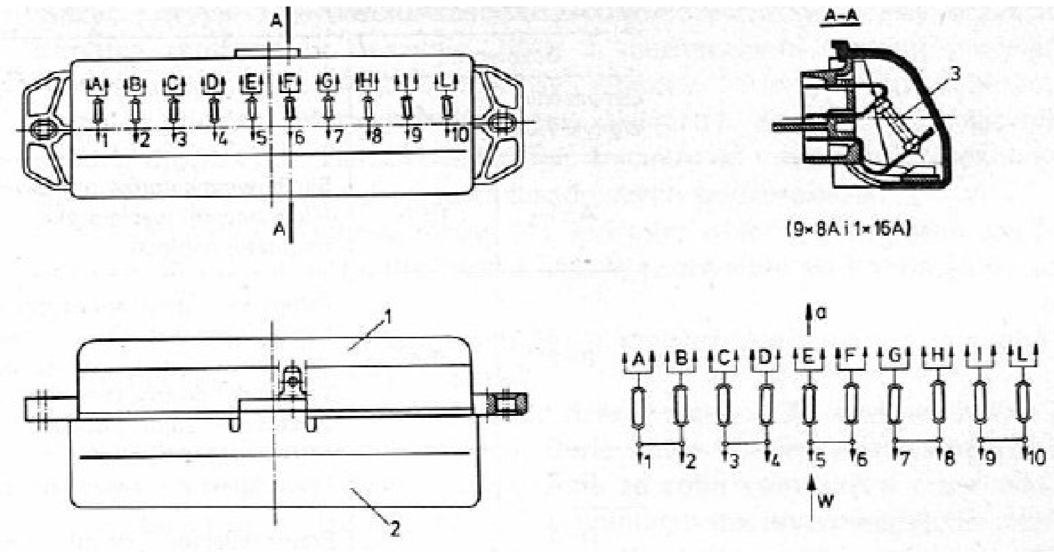


Figure 7.68: FUSE BOX (SKRZYNKA BEZPIECZNIKÓW)

1 - box body, 2 - cover, 3 - fuse

1 - korpus skrzynki, 2 - pokrywka, 3- bezpiecznik

Designation as per Fig. 7.68	Type	Protected Circuit
A-1	16 A	Heater fan motors (left and right) *Silniki wentylatorów nagrzewnic (lewej i prawej)* Wiper motor *Silnik napędu wycieraczki* Voltage regulator *Regulator napięcia*
B-2	8 A	Direction-indicator lamps (front and rear) *Lampy kierunkowskazów (przednich i tylnych)* Direction-indicator dashboard lamps *Lampki sygnalizacyjne kierunkowskazów* Fuel gauge indicator and sensor *Wskaźnik i czujnik poziomu paliwa* Motor temperature indicator and sensor *Wskaźnik i czujnik temperatury silnika* Oil pressure gauge and sensor *Wskaźnik i czujnik ciśnienia oleju*
C-3		Left headlamp - main-beam headlamp *Lewy reflektor - światło drogowe*
D-4		Right headlamp - main-beam headlamp *Prawy reflektor – światło drogowe* Traffic-light-signalling lamp *Lampka sygnalizacyjna świateł drogowych*
E-5		Left hand headlamp - dipped-beam *Lewy reflektor - światło mijania*
F-6		Right hand headlamp - dipped-beam *Prawy reflektor - światło mijania*
G-7		Right position (front and rear) lamp *Prawe światło pozycyjne (przednie i tylne)* Registration number plate lamp *Lampa oświetlenia tablicy numeru rejestracyjnego*
H-8		Left position (front and rear) lamp *Lewe światło pozycyjne (przednie i tylne)* Illuminating lamps for the instrument panel *Lampki oświetlenia tablicy wskaźników*
I-9		Stop/brake lamp light *Światła hamowania „Stop"* Cabin and tailgate interior lighting lamps *Lampy oświetlenia wnętrza kabiny i skrzyni ładunkowej*
L-10		Horn *Sygnał dźwiękowy* Plug-in socket for portable lamp *Gniazdo wtykowe lampy przenośnej*
List of additional electrical circuits protected by fuses in fire-fighting vehicles		
E-5	8 A	Left fog lamp *Lewy reflektor przeciwmgłowy*
F-6		Right fog lamp *Prawy reflektor przeciwmgłowy*
D-4		Relay of the auto-pump clutch *Przekaźnik sprzęgła autopompy*

7.25 Table: LIST OF FUSES (with "Bosch type" color)

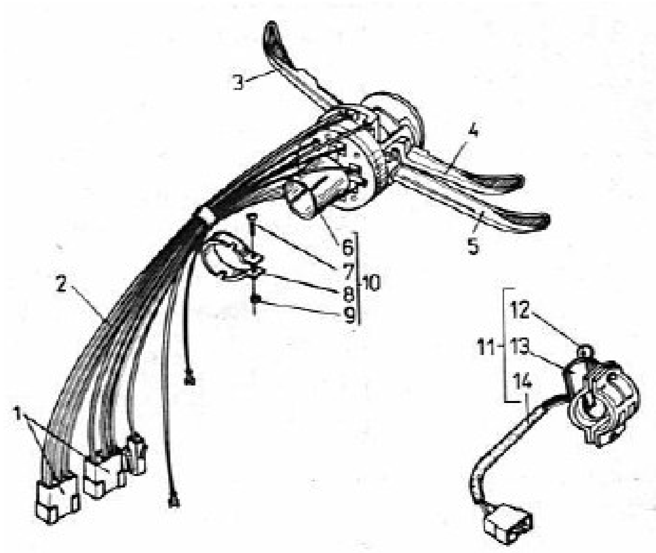
The ignition and starter circuits have no fuses. The burned fuses must be replaced with new ones (the circuits must not be protected with wires, plates, etc.). Before replacing a burnt-out fuse, find and remove the cause of the damage that caused it to burn out.

7.6.3 Switches for electrical equipment

The set of switches is placed on the control panel (Fig. 1.23 to 1.25). They are used to switch lights on and off and to switch electrical devices on.

In fire-fighting vehicles and containers, additional switches are used to switch on flashlights, double tone signals and fog lights.

The push-button switch consists of a plastic housing with catches to be mounted in the dashboard housing: inserts with contacts, contact plate and push buttons, mounted rotationally on the pivots of the dashboard housing.



7.69 Figure: LIGHT/WINDSCREEN WIPER/HORN SWITCHES

1 - plug connector, 2 - wire harness, 3 - glass or audio wiper switch lever, 4 - drive light switch lever, 5 - main-beam and light signal switch lever, 6 - switch sleeve, 7 - screw, 8 - clamping bracket, 9 - nut, 10 - switchplates, 11 - ignition switchplates, 12 - key, 13 - body, 14 - wiring harness

1 - złącze wtykowe, 2 - wiązka przewodów, 3 - dźwignia przełącznika wycieraczek szyby lub sygnału dźwiękowego, 4 - dźwignia przełącznika świateł kierunku jazdy, 5 - dźwignia przełącznika świateł drogowych oraz sygnału świetlnego, 6 - tuleja przełącznika, 7 - wkręt, 8 - obejma zaciskowa, 9 - nakrętka, 10 - wyłącznik kpl, 11 - wyłącznik zapłonu kpl, 12 - kluczyk, 13 - korpus, 14 - wiązka przewodów

In the event of contamination or burning of the contacts and plug connector tip of the insert; these malfunctions can be remedied by removing the plug connector from the Switch housing. To do this, insert a screwdriver between the Switch housing and the contact insert, lift it up and remove it with the contact strip. Dirty contacts should be cleaned with a cloth dampened in petrol. Contacts with slight burn marks can be filtered with a file and wiped with a cloth. In the case of deeper contact burnouts, the entire circuit breaker must be replaced. The main components of the main switch for main-beam headlamps, direction indicators, wipers and sound signals (Figures 7 to 69) are as follows:

- a direction-indicator control (4) which, when switched on, automatically returns to the neutral position as soon as the wheels are in the straight-ahead position,
- a main-beam headlamp switch (5) with a relay for the light signals (to the dipped-beam headlamp),
- a wiper and sound signal switch (3) located on the right hand side of the steering column. The two flange sleeves of the combined switch, top and bottom, are flanged together by riveting; the bottom sleeve (6) with holes in the flange has a supply cable outlet and

longitudinal slots in the lower part, which forms the basis for attaching the switch to the steering column.

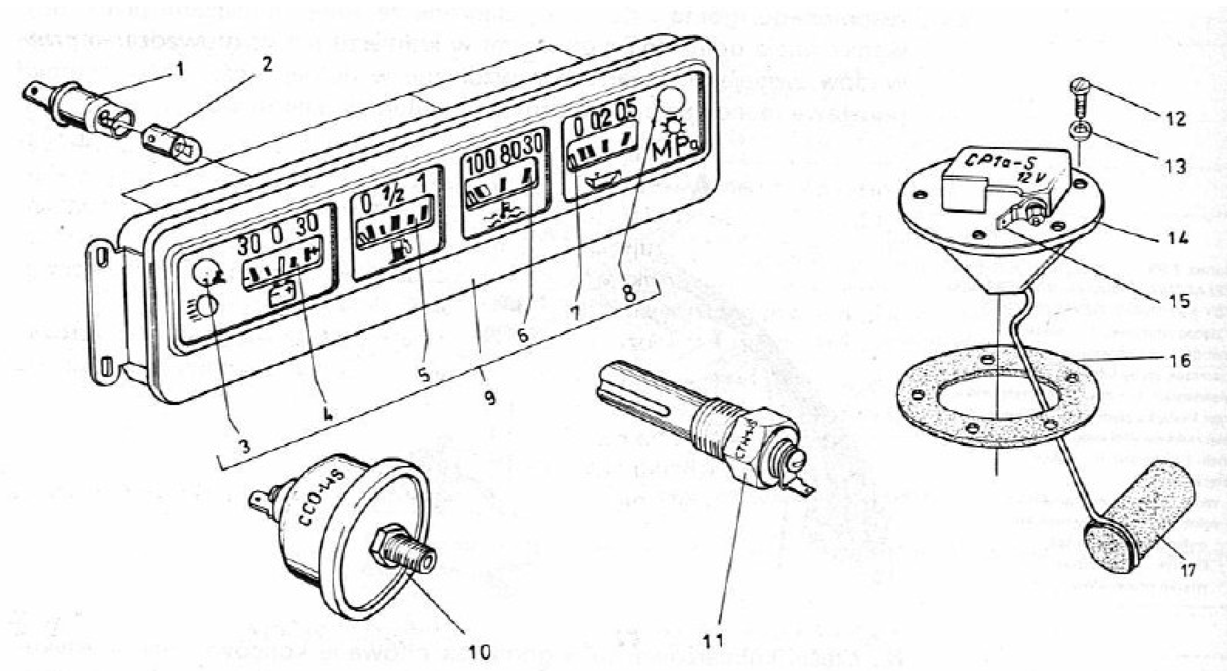
The flange part of the upper bushing is riveted with the connector ends of the supply lines. The relevant circuits are switched on via a lever. Lever (5) swivels downwards to switch on the dipped beam, and further swivels downwards to switch on the main beam.

Pivoting lever (3) downwards, it activates the windscreen wiper, and pulling upwards it activates the sound signal. Lever (4) swivels up or down to switch on the left or right hand indicators. The lower link (5), pulled upwards, closes a pair of light relay contacts, resulting in a flash of traffic light.

Dirty or burning contacts should be cleaned as in the case of a key switch. In case of deeper contact burnouts, weakening of the springs pressing the contact plates or breakage of the shut-off levers, the switch must be replaced with a new one. To replace a defective combination switch, remove the steering wheel and the two-piece steering column cover.

7.6.4 Indicators and sensors

The set of indicators (Fig. 7.70), which is attached to the instrument panel, contains: the ammeter (4), the fuel meter (5), the engine temperature indicator (6) and the oil pressure gauge (7), the main-beam headlamp tell-tale (3) and the position-indicator tell-tale (7). The indicators are connected by cables to the corresponding sensors in the engine and in the fuel tank. They are indelible and must be replaced in the event of damage.



1 - filament lamp holder, 2 - filament lamp (2 W). 3 - main-beam headlamp tell-tale (blue), 4 - charging current tell-tale (ammeter). 5 - fuel level indicator in the tank, 6 - engine temperature indicator, 7 - engine oil pressure indicator, 8 - control indicator lamp (green) for position lamps, 9 - set of indicators for the heating system, 5 - fuel level indicator in the tank, 6 - engine temperature indicator, 7 - engine oil pressure indicator, 8 - control indicator lamp (green) for position lamps, 9 - set of indicators for the heating system. 10 - engine oil pressure sensor, 11 - engine temperature sensor, 12 - screw (M5x10), 13 - washer, 14 - fuel level sensor, ppl. 15 - plug connectors, 16 - gasket, 17 - sensor float

1 - oprawka żarówki, 2 - żarówka (2 W). 3 - lampka kontrolna świateł drogowych (niebieska), 4 - wskaźnik prądu ładowania (amperomierz). 5 - wskaźnik poziomu paliwa w zbiorniku, 6 - wskaźnik temperatury silnika, 7 - wskaźnik ciśnienia oleju w silniku, 8 - lampka kontrolna świateł (zielona) pozycyjnych, 9 - zestaw wskaźników kpl. 10 - czujnik ciśnienia oleju w silniku, 11 - czujnik temperatury silnika, 12 - wkręt (M5x10), 13 - podkładka, 14 - czujnik poziomu paliwa kpl. 15 - złącza wtykowe, 16 - uszczelka, 17 - pływak czujnika

7.70 Figure: SET OF INDICATORS AND SENSORS

The connections of individual indicators can be reached by unscrewing two screws M6x22, fixing the dashboard to the shelf and tilting it as needed.

7.6.4 Indicators and sensors

■ The ammeter (4, Fig. 7.70) is an electromagnetic device, with a measuring range of 30 A, connected in series to the charging current circuit, between the battery and the terminal marked with the number "30" of the alternator.

When the motor is not running (the battery supplies the consumers), the ammeter pointer swings in the direction of discharge, i.e. to the left (-). After starting the engine, the alternator starts to work and the direction of the current flowing through the ammeter changes (the battery is being charged). The display accuracy of the ammeter is 5%. Replace the ammeter that indicates a charging or discharging current with a new one if it is larger than this.

■ The fuel meter (5, Fig. 7.70) consists of a fuel level sensor (14) mounted on the fuel tank, electric cables and an indicator (5) placed on the control panel. The sensor consists of a body made of a zinc alloy, a sliding resistance and a plastic float (17). It is powered by a battery via the indicator on the dashboard.

The float (17) is mounted on a lever so that it can swing up and down depending on the amount of fuel in the tank. This state is recorded by the second part of the sensor arm (14), moving along the resistor. By changing its resistance and the amount of current the indicator (4) indicates the fuel level in the tank.

Incorrect display of the fuel level in the tank may result in damage to the fuel level monitor or sensor. A faulty sensor must be adjusted or replaced. The sensor is adjusted by bending the float arm (17), which activates the resistance or bending of the float arm.

■The engine temperature measuring system (Fig. 7.70) consists of a temperature sensor (11) fitted to the engine head S-21 or the engine cooler 4C90 and the display (16) on the dashboard. The sensor cannot be repaired; in the event of damage or wear, it must be replaced with a new one. After the power supply to the measuring system is switched on, the pointer is located on the right side of the scale. When the motor temperature rises, the pointer is moved from the right to the left.

The indicator and temperature sensor are indelible and cannot be repaired; they must be replaced in the event of damage.

■ The engine oil pressure measuring system (Fig. 7.70) consists of a sensor (10) mounted on the oil filter or engine hull (4690) and a display (7) on the dashboard. This system is powered from the battery by an ignition switch. Depending on the pressure acting on the sensor diaphragm (10), the mobile contact pulsates alternately and the resultant current, corresponding to the actual oil pressure in the engine, flows through the indicator.

The measuring system may indicate a different pressure or zero pressure.

In the first case, this is due to a defect in the sensor or indicator, while in the second case, it may be due to a defect in the sensor or indicator:

- defective oil pump,
- power supply interruption of the indicator and sensor.

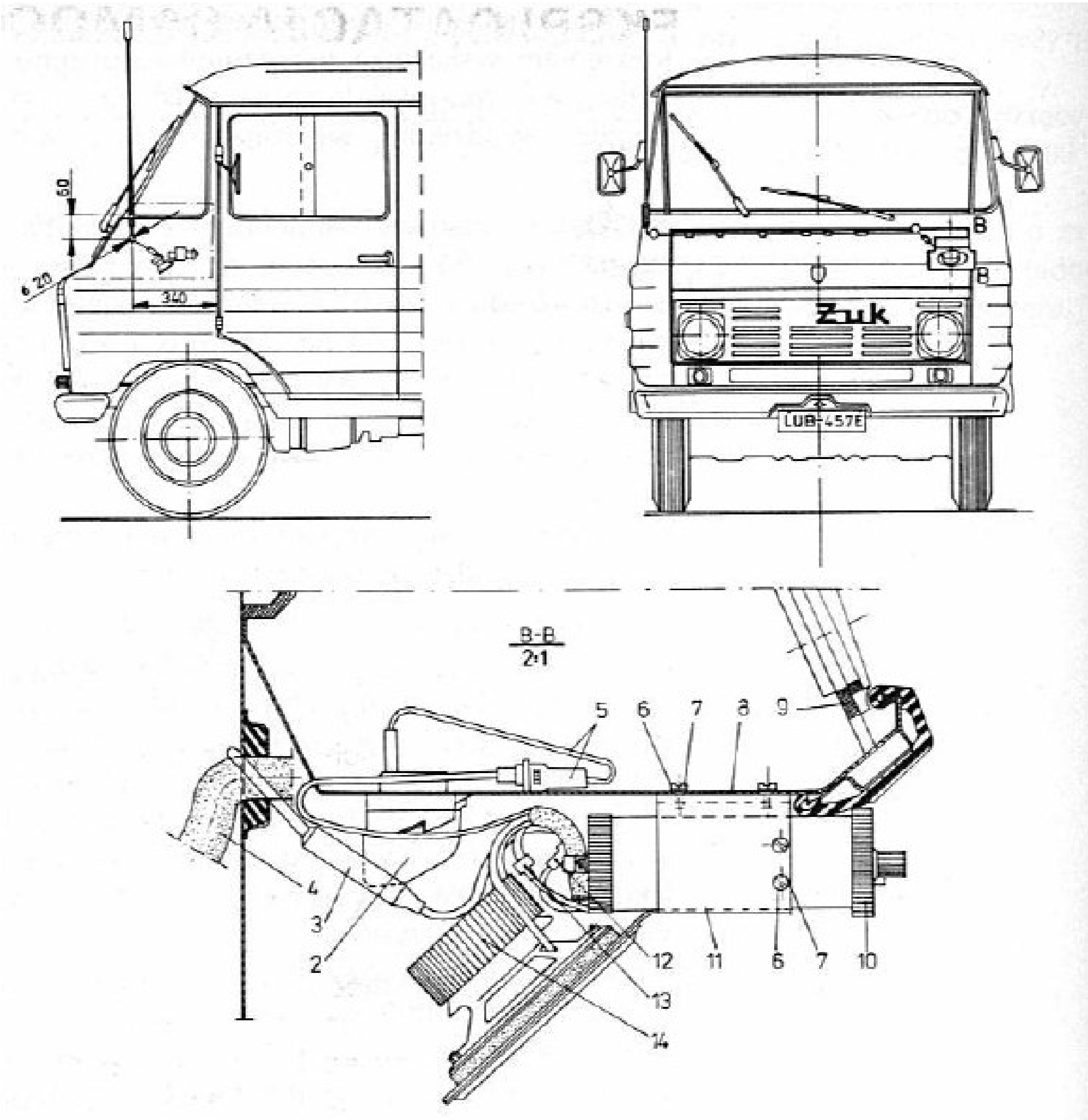
Sensors and indicators cannot be repaired and must be replaced in the event of damage.

7.6.5 Installation of the radio in the car

A radio receiver, e.g. SAFARI-2 (Fig. 7.71), can be installed in the car Żuk.

The place intended for mounting the radio is the lower shelf under the dashboard on the left side of the steering column. This receiver has four wavelength ranges, consumes 5 W, has dimensions 180x110x50 mm. The factory is adapting Żuk cars to install the radio as follows:

- mount the noise suppression capacitor on the ignition coil,
- drills four Ø 4.5 mm holes in the cab shelf for mounting the radio.



1 - loudspeaker, 2 - fuse box, 3 - plug socket, 4 - main wiring harness, 5 - radio power cord, 6 - spring washer, 7 - screw M4x16,8 - cab front shelf, 9 - dashboard, 10 - Safari-2 radio. 11 - radio mounting bracket, 12 - socket cable (+), 13 - socket cable (-). 14 - cable from the radio to the loudspeaker

1 - głośnik, 2 - skrzynka bezpieczników, 3- gniazdo wtykowe, 4 - wiązka główna przewodów elektrycznych, 5 - przewód zasilania radia, 6 - podkładka sprężysta, 7 - wkręt M4x16,8 - półka przednia kabiny, 9 - tablica rozdzielcza, 10 - radio Safari-2. 11 - wspornik mocowania radia, 12 - przewód (+) z nasadka, 13 - przewód (-) z nasadką. 14 - przewód od radia do głośnika

7.71 Figure: INSTALLATION OF THE RADIO

Installation of radio and loudspeaker. Screw the radio (10) and the speaker (1) to the bracket (11, fig. 7.71) using M3x16 screws (supplied with the radio). Separate the two-core cable (14) from the radio to the speaker at a length of 50 to 80 mm, then isolate it at a length of 7 mm and soldered the ends to the two speaker terminals. Cable (12) with socket, marked with "-" sign (black) should be connected to the contact of the radio housing (mask), located on the back of the receiver.

7.6.5 Installation of the radio in the car

Cable with socket, marked with "+" sign (red) Connect to a flat-plug cable that is plugged out of the receiver with the speaker and power cables. The bracket with attached radio and loudspeaker must be screwed to the shelf with four screws (6) M4x6 using spring washers.

Antenna mount and radio power supply. In the upper right corner of the cabin, drill a Ø 20 mm hole at the position specified by the dimensions 340 and 60 mm (fig. 7.71), then screw on the antenna and bend it to obtain the vertical position. Connect the antenna's plug connector (3) and the radio's plug by pushing them in as far as they will go.

Isolate the supply cable (5) 6 mm long and tighten the socket of the plug connector (F2.5) and the insulation pipe onto it, then connect it to the fuse box L-10 (fig. 7.1 - insert).

For proper operation of the radio receiver, proper operation and clean reception of the program, please read carefully the operating instructions supplied with each radio. However, it is best to have the radio and antennas installed in your car by ZURT[2] or ASO.

2 *Zakład Usług Radiotechnicznych i Telewizyjnych*: PRL-era network of state-owned commercial and service outlets selling and repairing home-made electronic devices.

8 OPERATION

Knowledge of construction and technical characteristics, as well as observance in practice of the principles of proper operation of the vehicle, allows for full utilization of its functional properties and achieving high mileage.

8.1 WARRANTY

Every new Zuk car is covered by the warranty. Detailed rules for granting the warranty are set out in the "Warranty Booklet", which the purchaser receives when purchasing the vehicle. During the warranty period, technical inspections (as discussed in Section 8.6) must be carried out at authorised service stations (ASOs).

Before being sold, the car is subjected to preliminary maintenance. In addition to maintenance, the oil loss in the engine lubrication system, the gearbox, the rear axle and the steering gear are also reduced and compensated for. The tank of the engine supply system shall be filled with approximately 5 dm^3 of fuel.

8.2 RUNNING IN

The running-in period of a new car, or after the main repair, includes the mileage of the first 1300...1700 km and is included in the period determining the reliability and durability of the car in its further use. During this period, there are significant movement resistances caused by increased friction and poorer lubrication conditions of the cooperating parts (not smooth surfaces, small clearances), which causes the mechanisms to overheat and mask and are subject to increased wear. Taking these circumstances into account, the vehicle should be taken special care of during the running-in period and used in accordance with the following recommendations:

- shall not be driven at a speed greater than that specified in Table 8-1 and the accelerator pedal shall not be tilted more than for 2/3 of the full stroke;
- the mass of the transported goods should not exceed 75% of the payload (see Table 1-2), and in more difficult conditions of use, the vehicle load and the speed of driving should be reduced proportionally;
- a loaded trailer should not be pulled behind the vehicle;
- avoid off-road driving (sand, wetland) and poorly paved roads;
- before starting to travel, the engine shall reach the operating temperature at which it reacts without delay to accelerator pedal movements.
- do not overheat the motor (the coolant temperature indicator should not be on the red scale field);
- do not overload the engine, i.e. operate the vehicle at low speed with a high degree of tilt of the accelerator pedal.

Gear	Vehicle version		
	B, H	C, D, I	F, G
Until 1500 km			
I	20	20	20
II	40	30	45
III	70	50	65
IV	-	70	80
V	-	-	85

8.1 Table: PERMISSIBLE SPEED DURING RUNNING IN

The steady motion of the car is achieved by balancing the forces of resistance and the driving force on the wheels. This imbalance increases or decreases the forward speed. A reduction in speed to that at which jerks occur in the power train means developing too little motive force in relation to the resistance to motion; this condition shall signal the immediate activation of a lower gear (an increase in wheel torque) and not an increase in the accelerator pedal tilt (overload of the engine).

Further recommendations for the use of the vehicle during the running-in process are as follows:

- do not allow one of the drive wheels to slip for more than 180 seconds (with the other wheel stationary) because the differential mechanism may become blurred;

- sudden acceleration and deceleration should be avoided due to the additional dynamic load on the mechanisms;
- when driving for a long time, check the temperature of the front wheel hubs and brake drums; if they are heating up, adjust the play in the front wheel hub bearings or the brake system;
- the maintenance of the running-in period must be carried out in a timely manner and to the fullest extent (Section 8.6). Particular attention should be paid to the attachment of car assemblies, components and parts. Tightening torques for major screw connections are given in Table 8-2.

List of fasteners	Thread markings	Tightening torque, N·m
S-21 engine		
Head screws	M14x2	107,8...117,6
Main bearing cover screws	M14	120,5...133,3
Screw nuts for crank handle cover	M10x1	66,5...73,5
Flywheel bolt nuts	M11x1	74,5...81,3
Screw nuts for the suction-exhaust line	M10x1	19,6
Exhaust pipe stirrup nuts	M8	14,7
Motor suspension screws	M12	44,1
CB engine		
Head screws	M12x1,5	98,0
Main bearing cover screws	M12x1,5	103,0
Screw nuts for crank handle cover	M11x1	69,0
Flywheel bolt nuts	M10x1,25	78,0
Screw nuts for the suction-exhaust line	M8	25,0
Crankshaft screw for fixing the pulley of the drive belt for the cooling pump and alternator	M20x1	137,0
Screws fixing the drive wheel to the camshaft	M10x1,25	78,0
Fixing bolt nuts for the valve lever shaft brackets	M8	19,0
Screw fixing the V-belt pulley to the cooling system pump hub	M8	20,0
4C90 engine		
Head stud nuts	M12x1,25	93...98
Head cap bolt nuts	M10	34...44
Main bearing cover screws	M14	147...157
Screw nuts for crank handle cover	M11x1	approx. 70...75 *
Flywheel screws	M12x1,25	127,5...136
Suction and exhaust pipe screw nuts	M8	14,7
Screw fixing the pulley and toothed pulley on the crankshaft	M16	186...196
Screw fixing the camshaft gear	M16	186...196
Nut for hub clamping adjusts injection angle	M16x1,5	78,5...88
Nuts for attaching the ejector pump to the bracket	M10	19,6
Injector yoke nut	M8	10...20
Nozzle nut	M18x1,5	50...70
Coupling nut for high pressure hose	M12x1,25	15...25
Fan Hub Fixing Nut	M6	58,8...68,6
* Tighten to the specified torque or higher until the screws are 0,110...0,140 mm longer.		

8.2 Table: TIGHTENING TORQUES FOR MAJOR THREADED CONNECTIONS

List of fasteners	Thread markings	Tightening torque, N·m
DO2 clutch		
Screws for attaching the clutch holder to the flywheel	M8	30,0
Screws fastening the clutch casing to the motor hull S-21	M10	24,5
Screws fastening the clutch housing to the engine flywheel housing 4C90	M12	44,1
200 DBR clutch		
Screws for attaching the clutch holder to the flywheel	M8	30,0
Screws fastening the coupling casing to the CB motor hull	M12x1,5	34,3
Gearbox type 16 and type A13.1		
Screw nuts for attaching the box to the clutch housing	M12x1,25	34,3
Crown nut for the main gearbox shaft	M20x1,5	117,6
Drive shaft flange end bolt nuts	M10x1,25	39,2
Gearbox type "Polonez"		
Screws fixing the gearbox to the clutch housing	M10x1,25	49,0
Main gearbox bout nut	M20x1	78,0
Fixing screw for the front bearing of the intermediate shaft	M12x1,25	93,0
Nut for fixing the intermediate roller rear bearing (five-speed box)	M18x1,5	118,0
Nuts for fixing the flexible joint to the drive shaft and to the flange end of the rear axle	M10x1,25	49,0
Drive shaft flange end bolt nuts	M10x1,25	39,2
Drive axle 18 (23)		
Crown nut for the main drive shaft of the gear unit.	M20x1,5	117,6
Screws for fixing the disc wheels to the differential housing Screw	M10x1,25	70...85
nuts for the rear housing of the bridge	M10x1	34,3...44,1
Drive bridge 3005 (3015)		
Crown nut for the main drive shaft of the gear unit.	M20x1,5	176...245
Screws fastening the disc wheel to the differential housing	M12x1,25	100...115
Fixing screws for the bearing cover of the differential housing	M12	105...112
Attachment screws for the main gear unit housing cover	M8	12
Carrier and running gear		
Screw nuts for fixing the front suspension beam to the frame	M12x1,25	39,2
Screw nuts for attaching the upper arm bracket to the suspension front bar	M12x1,25	39,2
Threaded bushings for the upper arm	special thread	107,8...127,4
Clamping screw of the upper ba of the control arm connector	M10	39,2
Corona nuts for attachment of lower control arm axles	M10x1	40,0
Threaded sleeves of the lower control arm	special thread	107,8...127,4
Threaded bolt of the upper control arm	M18	117,6...137,2
Lower control arm threaded pin nut	M18	117,6...137,2
Screw nuts for attaching the spring bowl to the lower control arm	M10x1	19,6
Nuts for the lower link pin of the front shock absorber	M8x1	12,7
Piston nut for rear shock absorber	M10x1,25	19,6
Corona nut for front suspension stabilizer connector	M11x1	24,5
Pin nuts and spring stirrup	M14x1,5	58,8
Corona nuts for shock absorber mounting AT-9	M12x1,25	39,2
Nuts for chassis wheel fixing	M14x1,5	98,0...117,6
Corona nuts for front wheel hub fitment	M24x1,5	98,0...117,6 **
** The tightening torque specified must be combined with the required bearing clearance (see sections 4.2.3. and 5.1.2.).		
		Tightening torque,

8.3 STARTING OF ENGINES

The ease with which the engine can be started depends primarily on its technical condition and ambient temperature. If the technical condition is not objectionable, the procedure is as follows.

8.3.1 Starting of S-21 and CB engines

Cold start of the engine at positive ambient temperatures (a 'cold engine' must define an engine the temperature of which is equal to the ambient temperature). When starting such a motor it is necessary to do so:

- apply the radiator shutter-plate at ambient temperatures below 10°C,
- switch on the battery disconnect device,
- press the clutch pedal,
- set the lever of the external gear-shifting mechanism to neutral,
- switch off the unnecessary electrical installation of the vehicle,
- remove the carburetor starter handle,
- switch off the starter by turning (clockwise) the ignition key in the ignition switch,
- release the ignition key immediately after starting the engine if it does not return to the "GO" position. (see section 1.6). Do not apply any pressure to the accelerator pedal when starting the engine, as the starting device, as explained in section 2.1.5, only operates with the mixture throttle closed.

Cold start of the engine in negative ambient temperatures. The procedure is the same as described above, however, in order to facilitate engine start-up, the car should be prepared for winter operation (pass the seasonal service OZ within the range discussed in chapter 8.6), and before starting the starter, using the crank handle (engine S-21), turn the crankshaft of the engine several times, in order to break up and distribute the thickened oil. At ambient temperatures below -15°C, additional preparation measures such as heating the coolant and oil (empty engine cooling and lubrication system; place liquid or oil containers in hot water tanks and refill systems) and heating the suction line (cover with hot water dampened rags) must be carried out.

The cold engine should be warmed up to a minimum of 30°C after start-up and before starting to drive. The necessary time to reach this temperature is 1...3 min, when the engine is running at the rotational speed at which the alternator starts charging the battery (pointer on the charging current indicator tilted to the right to the middle position). The motor must not be warmed up at a higher speed than specified.

The test of the correct degree of heating is the immediate reaction of the engine (without signs of "choking") to the movements of the accelerator pedal or the possibility of starting the car with the starting device switched off.

It is also possible to start driving with the starter unit switched on. This reduces the warm-up time of the motor. However, driving longer with the starter device not switched off (forgotten) increases fuel consumption and accelerates the wear of the crankshaft mechanism. This must be taken into account when using the specified method of motor heating.

The warm engine does not require starting of the starter unit, only the accelerator pedal must be gently depressed. You can start driving immediately after starting the engine.

8.3.1 Starting of S-21 and CB engines

The cause of difficulties in starting a warm engine, especially in high ambient temperatures, may be the phenomenon of fuel evaporation from the carburettor. Due to the possibility of battery discharge, the starter should not be switched on once for longer than 5 seconds, with a maximum of 5 times the starter can be switched on successively, at intervals of 30...60 seconds. The next start cycle can be repeated not earlier than after 3...5 minutes.

After several attempts to start the engine, the mixture may be overenriched, so called "engine flooded", which will prevent the engine from starting. Then, during the next start of the starter, fully depress the accelerator pedal (in a slow motion, so as not to start the pump accelerating the carburettor). If this procedure proves to be ineffective, the spark plugs should be removed and the crankshaft of the engine should be turned several times by switching the starter on for a short time (blowing out the cylinders). After turning on the candles and releasing the accelerator pedal, attempt to start the engine again.

Starting the engine by pushing or pulling the car may only be used in exceptional cases (discharged battery, damaged starter, etc.) and with special care.

The procedure is as follows. After the vehicle has been started up to 15...20 km/h and the ignition and second gear switches have been activated, the clutch must be gently engaged (the starting device must also be engaged when the engine is cold). When starting the engine, stop the vehicle and heat it up using one of the following methods before continuing to drive.

8.3.2 Starting the engine 4C90

Starting the engine at positive ambient temperatures (a 'cold engine' must define an engine the temperature of which is equal to the ambient temperature). When starting such a motor it is necessary to do so:

- apply the radiator shutter-plate (at ambient temperatures below 10°C),
- switch on the battery disconnect device,
- press the clutch pedal,
- set the gear lever to neutral,
- insert and turn the ignition key into the "GO" position,
- release the "STOP" lever rod (press the handle onto the fixed motor cover),
- switch on the injection pump by turning the accelerator pedal to the full stroke position,
- start the starter by turning the ignition key into the "START" position for not longer than 10 seconds.

If after this period the motor does not start up, repeat the starting procedure after a minimum of 60 seconds. The engine must be warmed up at idling speed for approximately 2 minutes before it is put into operation.

Cold start of the engine in negative ambient temperatures. The procedure is basically the same as described above, however, before starting the starter it is absolutely necessary to switch on the button for heating the glow plugs for up to 20 seconds and the car should be prepared for winter

operation (pass the seasonal operation of the SHE in the range discussed in chapter 8.6). At ambient temperatures below -15°C, the coolant and oil can be heated for ease of commissioning. See Section 8.3.1 for instructions on how to proceed.

Starting the warm engine at positive or negative ambient temperatures. The warm engine does not require the button for heating the glow plugs to be switched on. You can start driving immediately after startup.

Due to the possibility of discharging the battery, it is not recommended to start the starter for more than 10 seconds, and the starter test can be repeated a maximum of four times at intervals of 60 seconds.

It is not recommended to start the 4C90 engine by pushing or pulling the car.

8.4 OPERATION

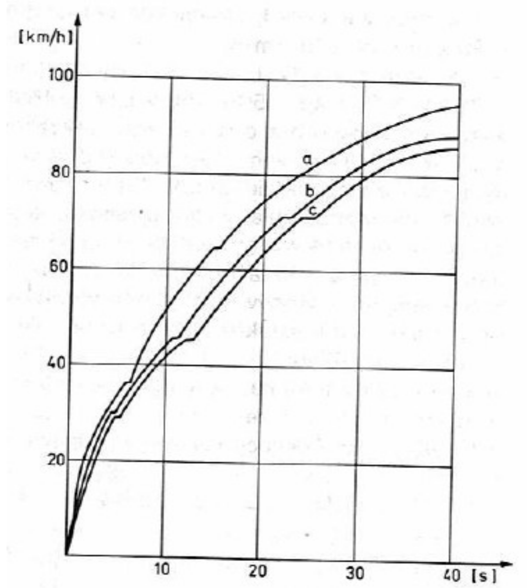
The way of driving depends primarily on the road conditions, weather conditions, the type and size of the loads carried and the skills of the driver. Users of Żuk cars should, in their own interest, get to know and master the rules of correct driving in various operating conditions, as it is connected with road safety and has a significant impact on the technical condition of the vehicle.

8.4.1 Riding under normal driving conditions

Once you have taken your seat, started and warmed up the engine and checked the indicators (steering and control device described in section 1.6), you can start driving. To this end, it is appropriate:

- release the auxiliary brake lever (lower),
- rress the clutch pedal,
- switch on 1st gear (starting 2nd gear is permitted on sloping terrain and recommended on roads with a low coefficient of adhesion),
- by gradually depressing the accelerator pedal, smoothly switch off the clutch pedal,
- educe the release speed of the clutch pedal and increase the engine speed slightly as soon as the power transmission to the running wheels starts,
- as soon as the car is rolling, switch off the clutch completely (remove the foot from the pedal) and continue to increase the engine speed.

Once the vehicle has been started up in first gear, shift to second gear and shift to subsequent gears.



8.1 Figure: ACCELERATING OVER THE GEARS

a - with an engine S-21, b - with an engine CB. c - with an engine 4C90

a - z silnikiem S-21, b - z silnikiem CB. c - z silnikiem 4C90

The acceleration of a fully laden vehicle by gears is shown in Figure 8.1.

Starting, starting and decelerating the vehicle (with downshifts) should be smooth and sensitive:

- operation of the clutch pedals and acceleration shall be synchronised; disengagement of the clutch before removing the leg from the acceleration pedal, as well as its delayed engagement, shall cause additional disc slippage and contribute to premature wear of the friction linings;
- it is recommended to switch the external lever of the gearshifting mechanism from 2nd to 1st gear (not synchronized in box 16) with the so-called "inter-gas"; after switching off the lever (in neutral position) switch on the clutch, increase the short-term crankshaft rotation

speed and after switching off the clutch switch on 1st gear; this way, after gaining experience, you can start gearing without clogging and risk of breaking off the gears teeth of the box;

- the reverse gear shall be engaged when the vehicle is at a complete standstill.

A moving car overcomes road resistance (rolling and hill resistance), air resistance and inertia resistance (acceleration, deceleration). Zuk has enough engine power to travel under normal road and weather conditions at the maximum speeds given in section 1.3. However, prolonged driving at these speeds is not recommended due to accelerated wear and tear of the vehicle's machinery, excessive fuel consumption and traffic safety. The highest speeds can be developed while accelerating the car or overtaking other road users in order to shorten the time of these manoeuvres.

The operating speed should always be lower than the maximum speed and should be adapted to the traffic conditions, the load of the vehicle, the skills and the well-being of the driver.

The minimum speed of movement of cars (fully laden, on a flat and even road) shall be:

- variants B, H: 1st gear - 5 km/h, 2nd gear - 15 km/h, 3rd gear - 30 km/h,
- variants C, D and I: 1st gear: 4 km/h, 2nd gear: 12 km/h, 3rd gear: 20 km/h, 4th gear - 30 km/h,
- variants F and G: 1st gear - 7 km/h, 2nd gear - 14 km/h, 3rd gear - 30 km/h, 4th gear - 50 km/h, 5th gear - 45 km/h.

Riding on roads with a lot of curves requires more care and experience. Zuk is a controlled car, i.e. when driving on a curve, the lifting angles of the rear wheels are smaller than the lifting angles of the front wheels and the car tends to widen the curve (to leave the track), which requires the driver to increase the turn of the wheels, despite moving in a fixed radius curve. For this reason, cornering should be carried out at limited speed. Do not start the acceleration until you have left the corner.

In a curve, a centrifugal force is applied to the vehicle at the centre of the mass. The position of the mass centre in Żuk cars in variants B, C and H (cars without load) is shown in figure 8.2 and specified in table 8-3. For cars in variants D, I - the mass centre is shifted forward and is located lower, and for cars in variants F and G - shifted backwards and located higher than in variant B.

Exceeding the speed limit depending on the traffic conditions (radius of curve, weather conditions, etc.) can result in tyre drift or wheel slippage (tipping over). In order to prevent such cases, it is necessary to:

- Always limit your driving speed before entering a curve,

- Distribute the load evenly and as low as possible over the entire bed of the carrier,

- do not overload the vehicle (the permissible axle loads are given in Table 1-2),

- do not use the vehicle, with damaged or worn tyres (the tread height of the tyre should be at least 2 mm) and maintain the recommended air pressure in the tyres.

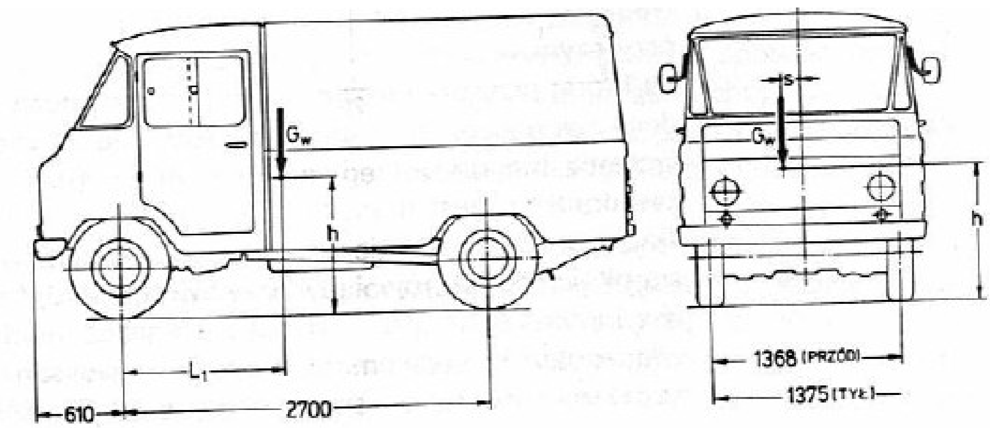
An experienced driver should be able to master the situation in the event of a loss of stability.

8.4.1 Riding under normal driving conditions

When lowering the rear of the vehicle, the front wheels should be turned in the direction of the casting (when lowering the rear, e.g. to the left, the front wheels should be turned also to the left) and immediately disconnected from the drive to the rear wheels by pressing the clutch pedal (do not brake).

Vehicle model	Distance from front axle (L), mm	Height above road surface (h), mm	Distance from the vehicle's longitudinal centre line (S), mm
A06	1150	562	33
A07	1240	580	28
A111	1130	846	25
A15	1583	960	30
A161	1207	808	24
A17	1398	992	17
A18	1334	883	31

8.3 Table: LOCATION OF THE CENTRE OF MASS OF THE CARS - VARIANTS B, C (AT UNLADEN WEIGHT)



G_W. - unladen kerb mass of the vehicle, h - height above the road surface. L_1 - distance from front axle. s- distance from the centreline of the vehicle

G_W. - masa własna samochodu, h - wysokość nad powierzchnią drogi. L_1 - odległość od osi przedniej. s- odległość od osi symetrii pojazdu

8.2 Figure: LOCATION OF THE CENTRE OF MASS OF THE VEHICLE

Safe driving on narrow mountain roads is largely dependent on the technical condition of the whole vehicle, in particular the driving equipment (steering and braking). The ability of Zuk cars to climb the hills (dynamic indicators on particular gears) is specified in chapter 1.3.

In many cases, it is advisable to switch on a lower gear in advance and to drive on it without the difficulties that can occur in case of high speed reduction (steep hills) and prolonged gear changes (e.g. difficulties with starting the first gear).

On descents, the engine shall be used to brake the vehicle, the gearbox being operated with the transmission (gears) on which the uphill slope was finally reached on the ascent. Driving with the drive switched off (external gearshift lever in neutral) and frequent use of the service brake is dangerous because of the reduction (by about 80%) in efficiency or even the loss of braking capacity as the brake linings, drums and fluid in the brake cylinders heat up.

It is not permitted to descend with the ignition system switched off and any gear engaged (the fuel drawn in is not burned in the combustion chambers, the oil is washed away from the cylinder

stones, it flows into the oil sump) and to remove the ignition key with the steering lock from the ignition switch, SE immobilises the steered wheels, inevitably leading to an accident.

Speed limit of 60 km/h is mandatory when **towing a trailer behind the vehicle**. Special care should be taken on roads with low (slippery) coefficient and grip, as well as during braking, overtaking and cornering.

Drawing a trailer loaded with an unladen vehicle and carrying persons on the trailer are not permitted. The trailer, after being attached to the vehicle, must be additionally protected against disconnection by means of a steel cable or chain.

Going backward requires special skill. Before performing this manoeuvre, make sure that the road behind the vehicle is clear. When reversing the combination, observe the behaviour of the trailer and adjust the direction of movement of the trailer by turning the front wheels of the vehicle (in the direction of deviation of the trailer). If this is not the case, move forward at the distance required to straighten the combination and repeat the reversing manoeuvre.

8.4.2 Driving in harsh road and atmospheric conditions

Difficult traffic conditions include driving on dirt roads, roads with a low coefficient of adhesion, overcoming water obstacles and driving in winter, in the rain or in fog. One difficulty, in normal weather conditions, is night riding. It acquires special features in difficult weather conditions, especially in fog and rain.

■ The way of riding on dirt roads with numerous bumps and ruts consists in riding at low speed in the first or second gear, with an average engine speed. Greater unevenness due to limited vehicle clearance (210 mm lateral, 290 mm longitudinal) should be avoided. If the ground is slippery (grass, clay, etc.), all manoeuvres, such as acceleration, braking or steering wheel movements, must be carried out calmly and smoothly so as not to lead to a loss of adhesion of the wheels and the vehicle being thrown off the ground.

■ When driving on sandy roads, due to the high traffic resistance, the engine speed should be increased and the engaged gear should allow to travel the entire distance without the need to change the gear ratio. If you try to change gear, you stop the car immediately. It will be difficult to get off the ground again. In this case, it is advisable to reverse the vehicle and only then drive forward. If this manoeuvre is not possible, lower the ground under the rear drive wheels and lay materials or objects underneath that will increase adhesion to the ground (stones, mats, branches, etc.). Starting without hardening the ground may cause the wheels to sag as a result of slippage until the car is hung on the rear axle. In case of frequent use of the vehicle on roads it is advisable to mount on all wheels tyres with off-road or muddy-snow tread.

■ The way of overcoming water obstacles (puddles, streams, etc.) with a depth of up to 340 mm and a hard bottom consists in driving at a constant speed (usually in the first gear) and increased rotational speed of the engine in order to prevent flooding of the ignition system (engines S-21 and CB) and the exhaust silencer. After passing through a water obstacle, the brake shoes and drums must be dried by attempting to brake several times and the clutch disc must be dried by switching the clutch off and on several times in order to restore their performance.

8.4.2 Driving in harsh road and atmospheric conditions

■ Driving on icy and snow-covered roads involves limiting the speed and performance of all activities related to driving the vehicle calmly and smoothly (in particular, acceleration, braking and steering wheel turns). In these conditions, fast driving is particularly dangerous (it is easy to slip the wheels and drop the car sideways). Only snowdrifts should be driven at a speed. Flat road sections or gradients should be chosen for stopping and stopping, as starting off - even under a slope of difficulty - usually fails.

Where rear wheel slip chains are used or studded mud and snow tyres are used, the speed should be limited to 40 km/h.

■ Running in the rain is difficult due to poor visibility and a marked reduction in the wet grip index of the tyres (especially in the first period after the start of rainfall, when dust and water form a thin layer of mud). In these conditions, it is advisable to limit the speed, the driving behaviour of roads with a low coefficient of adhesion and the activation of dipped-beam headlamps, wipers and air blows on the windscreen.

■ Driving in fog, which significantly reduces visibility, requires increased caution and a significant reduction in speed. Switch on the dipped-beam and rear fog lamps is mandatory and it is recommended to switch periodically on the windscreen wiper and washer system to improve visibility.

8.4.3 Rules for the economic operation of vehicles

The amount of operating costs depends mainly on the amount of used propellants, oils and greases, the amount of used tyres, expenditure on maintenance and repairs as well as on the amount of depreciation charges. All cost items (except depreciation) are related to the manner and conditions of using a car and taking care of its technical condition.

In order to reduce operating costs, it is necessary to

- run-in a new vehicle as described in section 8.2,
- comply with the instructions for proper use set out in sections 8.3 and 8.4,
- use the recommended fuel, oil and grease (Chap. 8.5),
- perform maintenance in a timely manner and in full scope (Section 8.6),
- do not overload the vehicle.

The basic indicator of the economical use of a car is the amount of fuel consumed by the engine per 100 km of vehicle mileage. Figure 8.3 shows the fuel consumption characteristics of the Zuk car, which runs directly in normal weather conditions on a flat, smooth and dry surface. Obviously, wear and tear is higher.

In order to reduce the fuel consumption it is necessary to

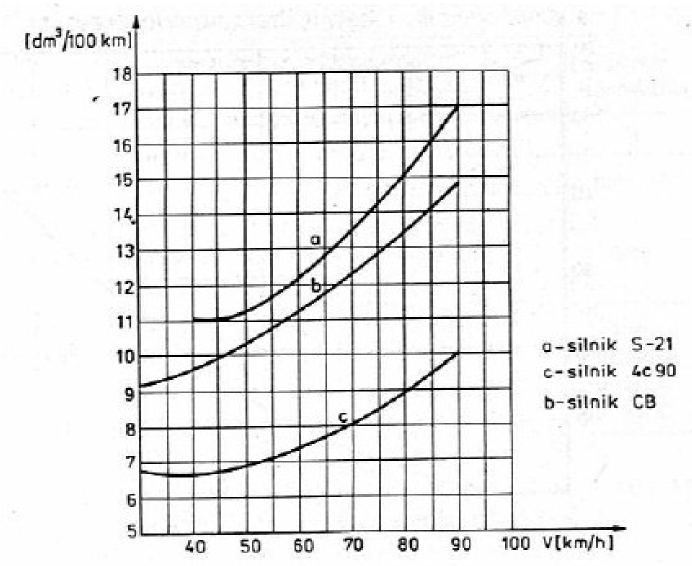
- take care of the good technical condition of the engine (mainly power and ignition systems),
- do not overload the motor,
- maintain the operating temperature of the motor at between 80°C and 90°C,

8.4.3 Rules for the economic operation of vehicles

- remember to switch off the starter unit while driving,
- switch off the engine when the vehicle is stationary for an extended period of time,
- avoid driving at maximum speed,
- take care of the technical condition and correct adjustment of the steering and braking systems,
- maintain the recommended tyre pressure.

The economical use of oils, greases and fluids depends primarily on the tightness of the assemblies and systems.

The highest consumption of engine oil is about 1,0 dm^3 per 1000 km.



a - a car with an engine S-21. b - a car with an engine CB, c - a car with an engine 4C90

a - samochodu z silnikiem S-21. b - samochodu z silnikiem CB, c - samochodu z silnikiem 4C90

8.3 Figure: FUEL ECONOMY PERFORMANCE

Good technical condition of the crankshaft system, lubrication system and engine crankcase ventilation system allows to reduce engine oil consumption.

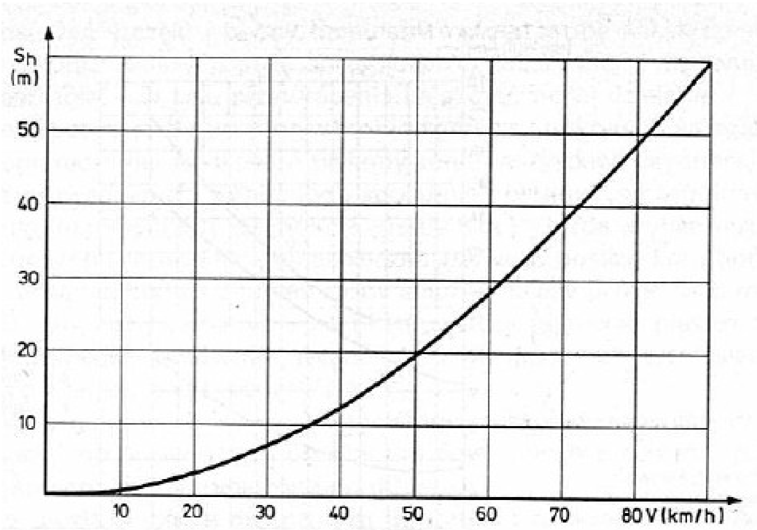
The running standard for radial tyre wear, used in Żuk cars, is 42 000 km. This standard (up to approx. 60 000 km) can be exceeded by following the instructions below. To this end, it is appropriate:

- maintain the recommended tyre pressure,
- ensure the cleanliness of the tyres (oils, greases, etc. accelerate the aging process),
- check the alignment of the front wheels as part of periodic maintenance and if you find it difficult to maintain a straight line of travel or observe uneven tyre tread wear,
- avoid high accelerations and severe braking,
- do not exceed the permissible axle loads.

8.4.4 Vehicle parking

Stopping the vehicle should be carried out in a smooth manner and should not endanger the safety of other road users. To do this, first slow down the speed and then move on:

- release the accelerator pedal (engine braking),
- switch off the clutch,
- progressively apply the service brake pedal and release the brake pedal slightly before stopping the vehicle,
- move the lever of the external gear-shifting mechanism to neutral,
- immobilise the engine by turning the ignition key or operating the STOP device in the case of a 4C90 engine; it is advisable, before immobilisation, to leave the engine idling for 1,5...2 minutes.



8.4 Figure: EFFECTIVE OPERATION OF THE BRAKING SYSTEM

The graph shows the dependence of the braking distance on the initial speed for a fully laden vehicle, driving on a road with an even and dry surface, with the pedal acting as a brake force of 490...540 N. The driving speed at the start of braking, the type and condition of the road surface and the condition of the tyres have a major influence on the length of the braking distance (with the braking system running smoothly).

Żuk's dual-circuit braking system also works in the event of a failure in one of the circuits; in this case, the service stroke of the brake pedal is increased and the braking efficiency is at most 30% of that of the fully-engineered braking system (in the event of a failure in the front wheel circumference).

In the event of a total failure of the service brake, the emergency brake is still at the driver's disposal. However, the braking distance, using only this brake, shall be approximately twice as long as the braking distance with the service brake (cold). The auxiliary brake, used as a parking brake, enables the vehicle to be stopped or stopped when fully loaded on a 16...20% slope. The parking

space (if conditions allow) should be chosen on a hard, flat and even surface, shaded in the spring-summer period and protected from the weather in the autumn-winter period.

When leaving the vehicle:

- apply the emergency brake and, if the vehicle is stationary on a slope, shift it to reverse or reverse gear,
- switch off the battery disconnect device (except in cases where reduced visibility conditions require the activation of the position lamps),
- secure and close the vehicle door.

8.5 CONSUMABLES

The fuel, oil, grease and liquid grades recommended for use in Żuk vehicles are presented in Table 8-4.

8.5 CONSUMABLES

Consumables		Period of application	Place of application
recommended	**substitutes**		
Petrol 86[3] Petrol 94	Petrol 94	year-round	- fuel tank of S-21 and CB engines
Diesel ILś	-	summer	- fuel tank of 4C90 engine
Diesel I Z-20 I Z-35 I Z-50	 - - -	winter - 12°C - 20°C - 30°C	
Multi-season engine oil Selektol Special SD SAE 20W/40 or Selektol Special SD SAE 10W/30	Lux 10 engine oil or Selektol Special SC SAE 20 W/30 multi-season engine oil	summer	- oil sump of S-21 engine
	Lux 6 engine oil or Selektol Special SC SAE 20W/30 multi-season engine oil	winter	
	Selektol Special SD SAE 30	summer	- oil sump of CB engine
	Selektol Special SD SAE 20W	winter	
Multi-seasonal oil Superol CC SAE 10W/30 or Milvus CC SAE 15W/40	-	summer	- oil sump of 4C90 engine
	CC - SAE 30	winter	
Hipol 15	Hipol 30	summer	- gearboxes A16, A13.1 - rear axle 18 (23) - steering gearbox - 4C90 engine pre-injection timing adjuster
	Hipol 10	winter	
Hipol 15 F	-	year-round	- gearbox "Polonez" - rear axle 3005 (3015)
Grease ŁT 43	Grease ŁT 4S3	year-round	- cooling system/pump bearings of engine S-21 - front wheel hub bearings - rear axle 18 wheel bearings (23)
Grease 1S		year-round	- drive spherical plain bearings
Grease STP for vehicle chassis	Grease ŁT 43	year-round	- grease nipples in the vehicle chassis - the bearing sleeves of the steering gear's intermediate levers
Graphite grease	-	year-round	- rear suspension springs - multiple spline for the drive shaft
AT oil	-	year-round	- hydraulic dampers for front and rear suspension
Brake fluid R3		year-round	- the reservoirs of the service braking system
Radiator coolant[4]	FRITOM fluid Paraflu 11 Petrygo fluid	winter	- engine cooling and cab heating systems
Water (soft)	-	summer	- windscreen washer system container
LAZURON or AUTOVIDOL	-	year-round	
Petroleum jelly TW	-	year-round	- Battery clamps
NB. The capacity of the main unit and system tanks is given in Table 1-8.			

8.4 Table: CONSUMABLES

The replacement consumables listed in the table may be used from time to time, however: Lux engine oils must not be mixed with Selektol oil, and an engine which has operated more than 20,000 km of a car in one oil grade is not recommended to change the oil grade at all (the change

3 *Etylina*, here translated "petrol", was the name of motor gasoline distributed at stations belonging to state monopoly *Centrala Produktów Naftowych* (CPN) in PRL-era.
4 *Borygo*, here translated "Radiator coolant", was the name of the usual coolant made by the Boryszew in PRL-era.

adversely affects the durability of the engine). Selectol, and in an engine that has operated more than 20 000 km of a car in one oil grade, it is not recommended to change the oil grade at all (the change adversely affects the durability of the engine). When changing from Lux 6 or 10 to Selektol SC SAE 20W/30 to machine oil in the OT-D range, after emptying the lubrication system, fill the engine oil sump with machine oil 8, start the engine for 5...10 minutes, drain the machine oil and fill the sump with fresh Selektol oil.

- brake fluids must not be mixed (the loss must be filled up with the same fluid). If there is a need to change the fluid species, the brake system shall be emptied and rinsed with spirit (as a last resort with a new fluid species), after which it shall be filled with a new fluid species.
- Borygo or Fritom automotive radiator fluids must not be mixed with each other or with any other fluids. Evaporation losses must be topped up with distilled water and leakage losses must be topped up with the same type of fluid as the filled system.

8.6 VEHICLE MAINTENANCE

8.6 VEHICLE MAINTENANCE

Maintenance is aimed at maintaining the high technical efficiency of the vehicle throughout its life cycle. Żuk car goes through the following types of maintenance:

- pre-maintenance (OTW).

- maintenance of the running-in period (OTD),

- maintenance (OT)

- day-to-day operation (OC),

- seasonal winter service (OZ) and summer service (OL).

The range of maintenance activities for vehicles of variants B, C, and H performed as part of OTW, OTD and OT are presented in Table 8-5 (todo). Lubrication activities performed as part of the above maintenance activities are presented in Table 8-6 (todo).

For cars in variants F and G (CB engine), the scope of maintenance and lubrication activities different from those for variants B, C and H is discussed in chapter 2.2.10, and for cars in variants D and I (4C90 engine) in chapter 2.3.13.

Table 8-7 gives an overview of the bearings used in the vehicle. The listed operating ranges and service intervals must always be read and understood in conjunction with the information in the operating manual provided with the vehicle. In the event of any discrepancies, it is essential to follow the recommendations of the Instructions.

An OTW is carried out by the seller, an OTD by authorised repairers, and an OT by authorised repairers during the warranty period (the condition of retaining warranty rights), while after the warranty period it is carried out by users or ASOs (depending on the maintenance base they have).

Each manufactured Zuk car is equipped with a set of tools and aids, which enable the user to perform simple maintenance and small current repairs. The standard equipment of the car is given in tables 8-8.

■ Daily maintenance (OC) of the vehicle is carried out by the user and covers the following range of activities.

Please check before leaving:

- the amount of fuel contained in the fuel tank,
- oil level in the engine oil sump,
- the level of liquid in the radiator and in the equalising tank of the cooling system,
- tension on the V-belt drive of the cooling system pump,
- visually inspect tyre condition (check tyre pressure once a week),
- the idle movement of the steering wheel, the condition of the steering linkages and joints,
- the level of brake fluid in the reservoirs of the service braking system,
- operation of exterior lighting, audible signal, windscreen washer and wiper system,

- tightness of power and brake systems,
- wheel fixing,
- operation of the emergency brake (parking brake),
- after the engine has been started up and warmed up, the service brake action (first immobilised and then in motion).

When you return to the permanent stopping point, you must do so:

- check the condition of the tyres (repair spare wheel if necessary),
- top up the oil level in the engine oil sump,
- fill up the fuel tank (the "full tank" principle ensures a constant readiness to leave and enables the fuel consumption to be monitored at all times),
- clean the vehicle,
- clean the interior of the bodywork compartment or the load platform,
- park the vehicle at a permanent standstill,
- apply the parking brake (in winter, due to the possibility of freezing of the shoes in the brake drums, switch on the 1st or 3rd gear without applying the parking brake),
- switch off the battery disconnect device,
- close and secure the vehicle door.

■ Seasonal maintenance is aimed at preparing the soother for operation in changing climatic conditions and should be carried out around 15 October for the autumn-winter period and around 15 April for the spring-summer period. Every time before seasonal maintenance, OT periodic maintenance, combined with oil change, must be carried out (unless the systems and assemblies were filled with multi-seasonal oils).

In addition, within the framework of seasonal winter service (OZ) it is necessary:

- fill the engine cooling system with anti-freeze (after rinsing with running water),
- check the function of the radiator shutter-plate, thermostat and driver's cab heating system,
- charge the battery and insulate the installation location (the inside of the passenger seat base),
- check the function of the automatic mixture heater, and in the dry air filter (for carburettor 28/35S2A1 or 28/35S2B1) move the shutter to position C (Fig. 2.51),
- check the technical condition of the steering and braking systems, the electrical system and the tyres (change to muddy and snow tyres if the system is to be used for a long time in difficult road conditions),
- check the function of the windscreen wiper and washer system; fill the windscreen washer system tank with antifreeze (e.g. Lazuron, Autovidol, etc.).

- equip the vehicle with an air intake blade, a towing cable, slip chains and a blade,
- check the condition of the fire extinguisher and refill the equipment of the first aid kit.

Within the framework of the seasonal summer service (OL), it is necessary:

- fill the cooling system (after rinsing with running water) with soft water,
- switch off the driver's cab heating system,
- charge the battery and remove any insulating material from the installation space,
- move the shutter-plate in the dry air filter to position B (Fig. 2.51),
- clean the fuel tank (see Chap. 2.1.10),
- check the technical condition of the steering mechanisms (grease the bushings of the steering gear intermediate levers), the electrical system and the tyres (replace tyres if necessary with tyres with road treads),
- check the condition of the fire extinguisher and refill the kit,
- conserve and store the equipment and accessories.

■ Store the vehicle. A vehicle for longer storage (up to six months) needs to be properly prepared and secured:

- washing the car and preserving its lacquered and chrome-plated surfaces,
- changing the oil in the engine and lubricating the chassis,
- emptying the fuel tank and cooling system,
- filling each cylinder (through the spark plug holes) with 3...5 cm^3 of engine oil and spreading it through the boulder by turning the crankshaft several times (using the crank handle),
- removing the battery and storing it in a warm place (during low temperatures); at positive temperatures, the battery may remain in the car, however, it must be recharged once every 6 weeks, regardless of its storage location,
- remove the wiper arms,
- wrapping (paper sticking, if any) the air filter inlet and the exhaust pipe outlet,
- positioning of the vehicle on the stands (the running wheels are raised above the ground) and halving the pressure of the tyres,
- conservation of tools and equipment.

The vehicle should be stored in a closed and dry room. At the end of a prolonged period of standstill, the vehicle must be maintained, inspected and assembled.

8.7 FIRE PROTECTION OF THE VEHICLE

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Fire safety depends primarily on the technical condition and knowledge of the basic fire regulations.

The most common causes of car fires are:

- short-circuits in the electrical system caused by poor insulation of the wires or the use of substitute fuses (wires),
- sparking in the supply circuit, motor start up, etc,
- starting the engine with the air filter or carburettor tube removed from the carburettor,
- leakage of the exhaust system,
- heating of the oil sump with open flames (during negative ambient temperatures),
- improper adjustment of the running wheel bearings and brake system,
- refuelling with an open flame.

In order to reduce the risk of fire, it is necessary to

- keep the vehicle's electrical system in perfect working order,
- keep the engine and its accessories clean,
- immediately remedy any noticed leaks in the supply and exhaust systems,
- periodically check the condition and fixing of the cables at the battery and starter terminals,
- switch the battery disconnect device off at standstill,
- ensure that the play in the running wheel bearings is adjusted correctly and that the brakes are not blocked (check the temperature of the hubs and drums when driving for long periods of time),
- take care of the efficiency of the extinguisher provided in the vehicle and be able to handle it.

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